mDot™ AT Command Guide

Models: MTDOT-xxx

Part Number: S000643, Version 4.0

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<table>
<thead>
<tr>
<th>Country</th>
<th>By Email</th>
<th>By Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe, Middle East, Africa:</td>
<td><a href="mailto:support@multitech.co.uk">support@multitech.co.uk</a></td>
<td>+(44) 118 959 7774</td>
</tr>
<tr>
<td>U.S., Canada, all others:</td>
<td><a href="mailto:support@multitech.com">support@multitech.com</a></td>
<td>(800) 972-2439 or (763) 717-5863</td>
</tr>
</tbody>
</table>

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AT+NJM Network Join Mode
AT+JOIN Join Network
AT+JR Join Retries
AT+JD Join Delay

Over-the-Air Activation (OTA)

AT+NI Network ID
AT+NK Network Key
AT+ENC AES Encryption

Manual Activation

AT+NA Network Address
AT+NSK Network Session Key
AT+DSK Data Session Key
AT+ULC Uplink Counter
AT+DLC Downlink Counter
AT+GK Generic App Key

Network Joining

OTA Network Join
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mDot™ AT Command Reference Guide
Chapter 1 – Introduction

AT Commands

This reference provides AT Command information for the MultiTech Dot Series. These commands are available in firmware Version 2.0.x and higher. Note that some commands are not available in older firmware versions.

- For mDot firmware upgrade instructions and to download the latest firmware, go to http://www.multitech.net/developer/software/mdot-software/mdot-firmware-upgrade/.
- For xDot firmware upgrade instructions and to download the latest firmware, go to http://www.multitech.net/developer/downloads/#xdot

Using Commands

Querying

Some commands allow you to query the current value. Enter the command with no argument or followed by a question mark (?):

- Query a value
  
  AT+TXP
  
  11
  
  OK

- Query a value with optional ?
  
  AT+TXP?
  
  11
  
  OK

Assigning New Values

Some commands allow you to assign a new value:

- To assign a new value, pass the value as an argument
  
  AT+TXP=10
  
  OK

- To see a range of input or output values for a command, give ? at the only argument.
  
  AT+TXP=?
  
  AT+TXP: (0–20)
  
  OK
Terminology

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>End device</td>
<td>Mote (sensor node)</td>
</tr>
<tr>
<td>EUI</td>
<td>Extended Unique Identifier (EUI), a 64-bit global identifier</td>
</tr>
<tr>
<td>Gateway</td>
<td>Concentrator or base station</td>
</tr>
<tr>
<td>Uplink</td>
<td>In the direction from end device to network server</td>
</tr>
<tr>
<td>Downlink</td>
<td>In the direction from network server to end device</td>
</tr>
<tr>
<td>ISM</td>
<td>Industrial, scientific and medical radio bands</td>
</tr>
<tr>
<td>Frequencies</td>
<td>US: 902-928MHz ISM band (915MHz)</td>
</tr>
<tr>
<td></td>
<td>EU: 863-870MHz ISM band (868MHz)</td>
</tr>
<tr>
<td>Channel frequencies</td>
<td>Physical layer</td>
</tr>
<tr>
<td></td>
<td>EU 868MHz</td>
</tr>
<tr>
<td></td>
<td>• 868,100,000Hz</td>
</tr>
<tr>
<td></td>
<td>• 868,300,000Hz</td>
</tr>
<tr>
<td></td>
<td>• 868,500,000Hz</td>
</tr>
<tr>
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<td>300bps to 50Kbps</td>
</tr>
<tr>
<td>OTA</td>
<td>Over the air</td>
</tr>
</tbody>
</table>

LoRa Topology

A LoRa network is usually a star or star of stars topology where gateways relay messages between end devices and a central network server. Gateways, like MultiTech’s Conduit, may contain the network server. However, the Conduit can be configured to work with an external network server. Gateways communicate with a network server over standard IP connections.
Chapter 2 – General AT Commands

**ATTENTION**

Attention, used to verify the COM channel is working. AT required at the beginning of every command.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>Attention</td>
</tr>
<tr>
<td>help AT</td>
<td>Help AT</td>
</tr>
<tr>
<td>AT=?</td>
<td>AT=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None

**Command with Response Examples**

```
AT
OK

help AT
AT: Attention
OK

AT=?
AT: NONE
OK
```

**REQUEST ID**

Request ID returns product and software identification information.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATI</td>
<td>Request ID</td>
</tr>
<tr>
<td>help ATI</td>
<td>Help ATI</td>
</tr>
<tr>
<td>ATI=?</td>
<td>ATI=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None
Command with Response Examples

ATI

MultiTech mDot
Firmware : 3.2.0-mbed51101
Library : 3.2.0-mbed51101
MTS-Lora : 3.2.0-mbed51101

help ATI

ATI: Request Identification
OK

ATI=?

ATI: NONE
OK

ATZ Reset CPU

Resets the CPU, the same way as pressing the reset button. The program is reloaded from flash and begins execution at the main function. Reset takes about 3 seconds.

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATZ</td>
</tr>
<tr>
<td>help ATZ</td>
</tr>
<tr>
<td>ATZ=?</td>
</tr>
</tbody>
</table>

Parameters and values

None

Command with Response Examples

ATZ
OK

help ATZ
ATZ: Reset the CPU
OK
ATE0/1  Echo Mode

Enable or disable command mode echo.

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATE=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help ATE</td>
</tr>
<tr>
<td>ATE=?</td>
</tr>
</tbody>
</table>

Parameters and Values

<table>
<thead>
<tr>
<th>Parameter1</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Disables echo</td>
</tr>
<tr>
<td>1</td>
<td>Enables echo (Default)</td>
</tr>
</tbody>
</table>

Command with Response Examples

ATE0

OK

ATE1

OK

ATV0/1  Verbose Mode

Enable or disable verbose mode. Affects the verbosity of command query responses. For example, without verbose mode, AT+IPR? responds with 115200. With verbose mode AT+IPR? responds with Serial Baud Rate: 115200. Does not affect OK responses.

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATV=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help ATV</td>
</tr>
<tr>
<td>ATV=?</td>
</tr>
</tbody>
</table>
Parameters and Values

Parameter 1

0     Disables verbose mode (Default)
1     Enables verbose mode

Command with Response Examples

ATV0
OK

ATV1
OK

AT&K0/3  Hardware Flow Control

Enable or disable hardware flow control. Hardware flow control is useful in serial data mode to keep from overflowing the input buffers.

This uses pins NCTS_DIO7(CTS) and RTS_AD6_DIO6(RTS). When in serial data mode, use hardware flow control to prevent buffer overflow. (Serial data mode is AT+SMODE=1 or AT+SD.) Changes CTS signal to low with &K0 and to high with &K3.

Note: RTS of the dot pinout is an output. When used as a DCE device, connect this RTS pin to the CTS of a connected DTE device. The dot RTS pin is an input and connects to CTS of a DTE interface.

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT&amp;K=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT&amp;K</td>
</tr>
<tr>
<td>AT&amp;K=?</td>
</tr>
</tbody>
</table>

Parameters and Values

Parameter 1

0     Disables hardware flow control
3     Enables hardware flow control

Command with Response Examples

AT&K0
OK

AT&K3
OK
AT&K?
3
OK

help AT&K
AT&K: AT&K0: disable, AT&K3: enable
OK

**AT&F    Reset to Factory Defaults**

Changes the current settings to the factory defaults, but does not store them. To store the default settings, use with AT&W. Otherwise, resetting or power cycling the device restores the previous settings.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT&amp;F</td>
</tr>
<tr>
<td>help AT&amp;F</td>
</tr>
<tr>
<td>AT&amp;F=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None

**Command with Response Examples**

AT&F

OK

help AT&F
AT&F: Reset current configuration to factory defaults

OK

AT&F=?
AT&F: NONE

OK

**Example US 915MHz**

AT&F
OK

AT&T

Device ID: be:7a:00:00:00:00:07:7a
Default Frequency Band: US915
Current Frequency Band: US915
Frequency Sub Band: 0
Network Mode: Public LoRaWAN
Start Up Mode: COMMAND
Network Address: 00000000
Network ID Passphrase:
Network Key: 2b.7e.15.16.28.ae.d2.a6.ab.f7.15.88.09.cf.4f.45
Network Key Passphrase:
Network Session Key: 00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00
Data Session Key: 00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00
Network Join Mode: OTA
Network Join Retries: 2
Preserve Session: off
Join Byte Order: LSB
Join Delay: 1
Join Rx1 DR Offset 0
Join Rx2 Datarate: DR8 - SF12BW500
Join Rx2 Frequency: 923300000
App Port: 1
Listen Before Talk: off
Link Check Threshold: off
Link Check Count: off
Error Correction: 1 bytes
ACK Retries: off
Packet Repeat: 1
Encryption: on
CRC: on
Adaptive Data Rate: off
Command Echo: on
Verbose Response: off
Tx Frequency: 0
Tx Data Rate: DR0 - SF10BW125
Min/Max Tx Data Rate: Min: DR0 - SF10BW125
Max: DR4 - SF8BW500
Tx Power: 30
Min/Max Tx Power: 0
30
Tx Antenna Gain: 3
Tx Wait: on
Tx Inverted Signal: off
Rx Delay: 1 s
Rx Inverted Signal: on
Rx Output Style: HEXADECIMAL
Debug Baud Rate: 115200
Serial Baud Rate: 115200
Serial Flow Control: off
Serial Clear On Error: on
Wake Mode: INTERVAL
Wake Interval: 10 s
Wake Delay: 100 ms
Wake Timeout: 20 ms
Wake Pin: DI8
Log Level: 0

OK

Example EU 868MHz

AT&F

OK
Device ID: be:7a:00:00:00:00:07:7a
Frequency Band: EU868
Frequency Sub Band: 0
Public Network: off
Start Up Mode: COMMAND
Network Address: 00000000
Network ID Passphrase: 2b.7e.15.16.28.ae.d2.a6.ab.f7.15.88.09.cf.4f.45
Network Key: 00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00
Data Session Key: 00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00
Network Join Mode: OTA
Network Join Retries: 2
Preserve Session: off
Join Byte Order: LSB
Join Delay: 1
App Port: 1
Link Check Threshold: off
Link Check Count: off
Error Correction: 1 bytes
ACK Retries: off
Packet Repeat: 1
Encryption: on
CRC: on
Adaptive Data Rate: off
Command Echo: on
Verbose Response: off
Tx Frequency: 0
Tx Data Rate: DR0 - SF12BW125
Tx Power: 11
Tx Antenna Gain: 3
Tx Wait: on
Tx Inverted Signal: off
Rx Delay: 1 s
Rx Inverted Signal: on
Rx Output Style: HEXADECIMAL
Debug Baud Rate: 115200
Serial Baud Rate: 115200
Serial Flow Control: off
Serial Clear On Error: on
Wake Mode: INTERVAL
Wake Interval: 10 s
Wake Delay: 100 ms
Wake Timeout: 20 ms
Wake Pin: DI8
Log Level: 0

OK
**AT+LW  LoRaWAN Version**

Shows support LoRaWAN MAC version.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+LW</td>
</tr>
<tr>
<td>help AT+LW</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None

**Command with Response Examples**

```
AT+LW
1.0.4
OK

help AT+LW
Show support LoRaWAN MAC Version
OK
```

**AT+FOTA  Firmware over the Air**

With FOTA enabled, the Conduit initiates the FOTA session. The Dot device responds to downlink messages automatically as needed. When the FOTA session is complete, the Dot device updates if the firmware successfully transferred, or deletes the FOTA session if the firmware transfer failed.

When you deploy Release 3.1 on an mDot, FOTA will be enabled by default.

Use this command to query the FOTA state and enable/disable/reset FOTA.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+FOTA=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+FOTA</td>
</tr>
<tr>
<td>AT+FOTA?</td>
</tr>
<tr>
<td>AT+FOTA=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

<table>
<thead>
<tr>
<th>Parameter1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
</tbody>
</table>
1 Enable FOTA (Default)
2 Reset FOTA
3 Multicast session information.

**Command with Response Examples**

AT+FOTA=1
OK

AT+FOTA=3
0 (0 seconds until session or multicast session in progress)
OK

AT+FOTA=3
-1 (No multicast session scheduled or in progress)
OK

AT+FOTA=3
23521 (23521 seconds until multicast session)
OK

help AT+FOTA

AT+FOTA: Set FOTA (0: DISABLE, 1: ENABLE, 2: RESET, 3: MULTICAST SESSION INFO)

OK

AT+FOTA=?

AT+FOTA: (0-3)

OK
**AT&W  Save Configuration**

Writes configuration settings to flash memory.

**Note:** Settings written by this command include all configuration settings displayed in AT&V.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT&amp;W</td>
</tr>
<tr>
<td>help AT&amp;W</td>
</tr>
<tr>
<td>AT&amp;W=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None

**Command with Response Examples**

```
AT&W
OK

help AT&W
AT&W: Save configuration to flash memory
OK

AT&W=?
AT&W: NONE
OK
```
**AT+WP  Wake Pin**

Sets the pin that the end device monitors if wake mode is set to interrupt mode. The end device wakes if a positive going edge is detected on the wake pin. Upon waking, it waits +WD amount of time for an initial character then +WTO amount of time for each additional character.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+WP=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+WP</td>
</tr>
<tr>
<td>AT+WP?</td>
</tr>
<tr>
<td>AT+WP=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

**mDot**

Parameter1

1  DIN
2  AD2_DIO2
3  AD3_DIO3
4  AD4_DIO4
5  ASSOCIATE_AD5_DIO5
6  RTS_AD6_DIO6 (Not available with AT&K3)
7  NCTS_DIO7 (Not available with AT&K3)
8  NDTR_SLEEPRQ_DI8 (Default)

**xDot**

Parameter1

1  UART1_RX
2  GPIO0
3  GPIO1
4  GPIO2
5  GPIO3
6  WAKE

**Command with Response Examples**

AT+WP?
DI8
OK

help AT+WP
AT+WP: Wakeup DIO pin of sleep mode (1-8) (default: DI8, 1:DIN), deep-sleep uses DIO7

OK

AT+WP=?
AT+WP: (1-8)

OK

**AT+IPR  Serial Speed**

Sets serial baud rate for interface on header pins 2 and 3. Changes to this setting take effect after a save and reboot of the Dot.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+IPR=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+IPR</td>
</tr>
<tr>
<td>AT+IPR?</td>
</tr>
<tr>
<td>AT+IPR=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

- 1200
- 2400
- 4800
- 9600
- 19200
- 38400
- 57600
- 115200 (Default)
- 230500
- 460800
- 921600

**Command with Response Examples**

AT+IPR
115200
OK
AT+IPR?
115200
OK
help AT+IPR
AT+IPR: Set serial baud rate, default: 115200
OK
AT+IPR=?
AT+IPR: (2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600)
OK

**AT+DIPR  Debug Serial Speed**

Sets debug serial baud rate for interface on DEBUG header pins 30 and 31. Changes to this setting take effect after a save and reboot of the Dot. power-cycle or reset.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+DIPR=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+DIPR</td>
</tr>
<tr>
<td>AT+DIPR?</td>
</tr>
<tr>
<td>AT+DIPR=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

2400
4800
9600
19200
38400
57600
115200 (Default)
230500
Command with Response Examples

AT+DIPR
115200
OK

AT+DIPR?
115200
OK

help AT+DIPR
AT+DIPR: Set debug serial baud rate, default: 115200
OK

AT+DIPR=?
AT+DIPR: (1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600)
OK

**AT+LOG**  
**Debug Log Level**

Sets the debug message logging level. Messages are output on the debug port. Higher settings log more messages.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+LOG=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+LOG</td>
</tr>
<tr>
<td>AT+LOG?</td>
</tr>
<tr>
<td>AT+LOG=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Off – No debug messages (Default)</td>
</tr>
<tr>
<td>1</td>
<td>FATAL – Output FATAL debug messages</td>
</tr>
<tr>
<td>2</td>
<td>ERROR – Outputs ERROR and FATAL debug messages</td>
</tr>
<tr>
<td>3</td>
<td>WARNING – Outputs WARNING and all lower level debug messages</td>
</tr>
<tr>
<td>4</td>
<td>INFO – Outputs INFO and all lower level debug messages</td>
</tr>
</tbody>
</table>
5 DEBUG – Output DEBUG and all lower level debug messages
6 TRACE – Output TRACE and all lower level debug messages

Command with Response Examples

AT+LOG=0
OK

AT+LOG?
0

OK

help AT+LOG
AT+LOG: Enable/disable debug logging. (0: off, 1:Fatal - 6:Trace)
OK

AT+LOG=?
AT+LOG: (0-6)
OK

AT+REPAIR=1 Erase Flash and Rewrite Config Files
Repair flash file system. This command erases the flash and rewrites the configuration files.

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+REPAIR=&lt;parameter 1&gt;</td>
</tr>
<tr>
<td>help AT+REPAIR=1</td>
</tr>
</tbody>
</table>

Parameters and Values

Parameter1
  Repair Flash Filesystem (1)

Command with Response Examples

AT+REPAIR=1
OK
AT+REPAIR
AT+REPAIR: Repair file system
OK

**AT+PP  Ping Slot Periodicity**

Set the Class B ping slot periodicity as number of pings per interval up to 128 seconds, $2^{(7 - \text{periodicity})}$.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+PP=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+PP</td>
</tr>
<tr>
<td>AT+PP?</td>
</tr>
<tr>
<td>AT+PP=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

<table>
<thead>
<tr>
<th>Parameter1</th>
<th>Value</th>
<th>How often the end device opens a ping slot during the beacon_window interval.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>Approximately every second.</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Every 2 seconds.</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Every 4 seconds.</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Every 8 seconds.</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Every 16 seconds.</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>Every 32 seconds.</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>Every 64 seconds.</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>Every 128 seconds, which is the maximum ping period supported by the LoRaWAN Class B specification.</td>
</tr>
</tbody>
</table>

**Command with Response Examples**

AT+PP=7

OK

help AT+PP

AT+PP=4
OK

AT+PP=?

AT+PP: (0-7)

OK

**AT+GPSTIME**   **GPS Time**

Use this to retrieve GPC synchronized time in milliseconds.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+GPSTIME</td>
</tr>
<tr>
<td>help AT+GPSTIME</td>
</tr>
<tr>
<td>AT+GPSTIME?</td>
</tr>
<tr>
<td>AT+GPSTIME=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None

**Command with Response Examples**

AT+GPSTIME
1233592440906

OK

**AT+BLS**   **Beacon Lock Status**

Indicates if the beacon is locked or unlocked. A Class B end-device will start as Class A and attempt to acquire a Beacon signal from the network before opening synchronized Rx windows. Once AT+BLS returns 1 to note that a beacon has been locked, the end-device must send an uplink to notify the network that it is ready to receive downlinks in the Class B windows.

- 0 - Not locked
- 1 - Locked

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+BLS</td>
</tr>
</tbody>
</table>
### Command Table

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>help AT+BLS</td>
</tr>
</tbody>
</table>

### Parameters and Values

None

### Command with Response Examples (for setup of a Class B device)

```
help AT+BLS
AT+BLS: Get the lock status of the beacon (0: not locked, 1: locked)
OK

AT+DC
A
OK
AT+DC=B
OK

AT+BLS
0
OK

OK
AT+BLS
1
OK
AT+DC
B
OK
AT+SEND
OK
<<< Packets can not be received in Class B windows >>>
```

### AT+BAT  Battery Level

Sets battery level descriptor.
Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+BAT</td>
</tr>
<tr>
<td>help AT+BAT</td>
</tr>
<tr>
<td>AT+BAT?</td>
</tr>
<tr>
<td>AT+ANT=?</td>
</tr>
</tbody>
</table>

Parameters and Values

Parameter 1

0 - 255  Maximum is 255

Command with Response Examples

AT+BAT
255
OK

AT+BAT=123
OK

AT+BAT
123
OK
**AT+MEM**  **Available RAM**

Shows available RAM.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+MEM</td>
</tr>
<tr>
<td>help AT+MEM</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None

**Command with Response Examples**

```
AT+MEM
114704 bytes
OK

help AT+MEM
AT+MEM: Available RAM
OK
```
Chapter 3 – Network Management

Configuring

**AT+DI  Device ID**

The device ID is an EUI. The EUI is programmed at the factory. This command allows you to query and also change the device EUI.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+DI</td>
</tr>
<tr>
<td>help AT+DI</td>
</tr>
<tr>
<td>AT+DI=&lt;parameter 1&gt;</td>
</tr>
<tr>
<td>AT+DI=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

| Parameter 1 | Device EUI-64, hex: 8 |

**Command with Response Examples**

AT+DI  
00-80-00-00-00-00-00-06

OK

AT+DI=00-80-00-00-00-01-58-35  
00-80-00-00-00-01-58-35  
Change the Device EUI

OK

help AT+DI  
AT+DI: Device EUI-64 (MSB) (unique, set at factory) (8 bytes)

OK

AT+DI=?  
AT+DI: (hex:8)

OK
**AT+DFREQ**  **Default Frequency Band**

Use to query or set the protected factory default frequency band/channel plan. Selections include: NONE, US915, AU915, EU868, AS923, KR920, AS923-JAPAN, IN865, or RU864.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>help AT+DFREQ</td>
</tr>
<tr>
<td>AT+DFREQ?</td>
</tr>
<tr>
<td>AT+DFREQ=&lt;parameter 1&gt;</td>
</tr>
<tr>
<td>AT+DFREQ=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter 1  (NONE,US915,AU915,EU868,AS923,KR920,AS923-JAPAN,IN865,RU864)

**Command with Response Examples**

```
AT+DFREQ?
US915
OK

AT+DFREQ=EU868
OK

AT+DFREQ?
EU868
OK

help AT+DFREQ=?
AT+DFREQ: (NONE,US915,AU915,EU868,AS923,KR920,AS923-JAPAN,IN865,RU864)
OK

AT+DFREQ=?
AT+DFREQ: (NONE,US915,AU915,EU868,AS923,KR920,AS923-JAPAN,IN865,RU864)
OK
```

This information also appears in the AT&V results.

**AT+FREQ**  **Frequency Band**

Use to query the current frequency band. This is not configurable. It depends on the channel plan.
Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+FREQ</td>
</tr>
<tr>
<td>help AT+FREQ</td>
</tr>
<tr>
<td>AT+FREQ?</td>
</tr>
<tr>
<td>AT+FREQ=?</td>
</tr>
</tbody>
</table>

Parameters and Values

None

Command with Response Examples

AT+FREQ
US915
OK

AT+FREQ
KR920
OK

AT+FREQ?
US915
OK

help AT+FREQ
AT+FREQ: Current Frequency Band of Device 'US915', 'AU915', 'EU868', 'AS923', 'KR920', 'AS923-JAPAN', 'IN865', or 'RU864
OK

AT+FREQ=?
AT+FREQ:
OK

**AT+FSB Frequency Sub-Band (915MHz models only)**

Configures the frequency sub-band for 915MHz models. This enables hybrid mode for private network channel management.

**Note:** AT+TXCH lists channels used in the current AT+FSB setting.
### Channel Details (AT+PN=0)

<table>
<thead>
<tr>
<th>AT+FSB</th>
<th>Uplink Channels</th>
<th>Downlink on Rx1 and Rx2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>902.3-903.7 - 125k, 903.0 500k</td>
<td>923.3 kHz</td>
</tr>
<tr>
<td>2</td>
<td>903.9-905.3 - 125k, 904.6 500k</td>
<td>923.9 kHz</td>
</tr>
<tr>
<td>3</td>
<td>905.5-906.9 - 125k, 906.2 500k</td>
<td>924.5 kHz</td>
</tr>
<tr>
<td>4</td>
<td>907.1-908.5 - 125k, 907.8 500k</td>
<td>925.1 kHz</td>
</tr>
<tr>
<td>5</td>
<td>908.7-910.1 - 125k, 909.4 500k</td>
<td>925.7 kHz</td>
</tr>
<tr>
<td>6</td>
<td>910.3-911.7 - 125k, 911.0 500k</td>
<td>926.3 kHz</td>
</tr>
<tr>
<td>7</td>
<td>911.9-913.3 - 125k, 912.6 500k</td>
<td>926.9 kHz</td>
</tr>
<tr>
<td>8</td>
<td>913.5-914.9 - 125k, 914.2 500k</td>
<td>927.5</td>
</tr>
</tbody>
</table>

**Note:** Rx1 and Rx2 Downlink on 923.3 - 927.5 depending on uplink channel used (channel / 8)

### Channel Details (AT+PN=1 or 2)

<table>
<thead>
<tr>
<th>AT+FSB</th>
<th>Uplink Channels</th>
<th>Downlink channels on Rx1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>902.3-903.7 - 125k</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>903.9-905.3 - 125k</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>905.5-906.9 - 125k</td>
<td>923.3-927.5 - 500kHz</td>
</tr>
<tr>
<td>4</td>
<td>907.1-908.5 - 125k</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>908.7-910.1 - 125k</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>910.3-911.7 - 125k</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>911.9-913.3 - 125k</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>913.5-914.9 - 125k</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Rx1 Downlink on 923.3 - 927.5 depending on uplink channel used (channel % 8) Rx2 Downlink on 923.3

### Syntax

**Command**

AT+FSB=<parameter1>

help AT+FSB

AT+FSB?

AT+FSB=?

### Parameters and Values

**Parameter1**

0    Allows channel hopping of all 64 channels. (Default)
1. Enter a value from 1-8 to configure the end device to use one set of eight channels out of 64 possible. This must match the gateway settings.

**Command with Response Examples**

AT+FSB
0

OK

AT+FSB?
0

OK

help AT+FSB
AT+FSB: Set the frequency sub-band for US 915, (0:ALL, 1-8)

OK

AT+FSB=?
AT+FSB: (0-8)

OK

**AT+PN Public Network Mode**

*In firmware Version 3.1, a private MTS network feature was added to this command. Parameter values changed to values listed in Parameters.*

Configures the end device to function on a public or private LoRaWAN network or a private MTS network. When either public or private LoRaWAN network is enabled, the device functions as a LoRaWAN device as specified in LoRa Alliance documentation.

**Private MTS Network**

When you enable Private MTS mode, the device operates on a private network with the following modifications adjusted for the local network server available on the Conduit:

- Syncword 0x12 is used
- Select downlink frequencies for US915/AU915 using UPLINK-CHANNEL / 8. For example, an uplink using channel 34 would be responded to in Rx1 on 500 kHz Channel 4.
- Join Delay settings are independently configurable with the AT+JD command (refer to AT+JD).
- Private MTS default Join windows open at 0.5 seconds after transmission ends for OTA.
- Rx1 and Rx2 windows are fixed to each AT+FSB setting (refer to AT+FSB).

**LoRaWAN Public**

This is the default setting.

- Syncword 0x34 is used.
- Select downlink frequencies for US915/AU915 using UPLINK-CHANNEL % 8. For example, an uplink using channel 34 would be responded to in Rx1 on 500 kHz Channel 2.
- Join Delay settings are independently configurable with the AT+JD command (refer to AT+JD). LoRaWAN Join windows open at the default 5/6 seconds after end of transmission for OTA.
- Set AT+FSB=1-8 to enable hybrid functionality (refer to AT+FSB).

**LoRaWAN Private**
- Syncword 0x12 is used.
- Select downlink frequencies for US915/AU915 using UPLINK-CHANNEL % 8. For example, an uplink using channel 34 would be responded to in Rx1 on 500 kHz Channel 2.
- Join Delay settings are independently configurable with the AT+JD command (refer to AT+JD). LoRaWAN Join windows open at the default 5/6 seconds after end of transmission for OTA.
- Set AT+FSB=1-8 to enable hybrid functionality (refer to AT+FSB).

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+PN=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+PN</td>
</tr>
<tr>
<td>AT+PN?</td>
</tr>
<tr>
<td>AT+PN=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Private MTS network mode</td>
</tr>
<tr>
<td>1</td>
<td>Public LoRaWAN network mode. (Default)</td>
</tr>
<tr>
<td>2</td>
<td>Private LoRaWAN network mode.</td>
</tr>
</tbody>
</table>

**Command with Response Examples**

```
AT+PN=0
OK

help AT+PN

AT+PN: Set public network mode (0: PRIVATE_MTS, 1: PUBLIC_LORAWARE, 2: PRIVATE_LORAWARE)

OK

AT+PN=?
```
AT+PN: (0-2)

OK

**Public/Private LoRaWAN Mode Example**

US 64 channel
AT+FSB=0
(AT+PN=1) sets the SyncWord to 0x34
(AT+PN=2) sets the SyncWord to 0x12
(AT+JD=5) sets Join Delay to 5 seconds
Downlink channel is (uplink_channel modulo 8)
OK

**Public/Private LoRaWAN Hybrid Mode Example**

US 8 channel
AT+FSB=(1 - 8)
(AT+PN=1) sets the SyncWord to 0x34
(AT+PN=2) sets the SyncWord to 0x12
(AT+JD=5) sets Join Delay to 5 seconds
Downlink channel is (uplink_channel modulo 8)
OK

**Private MTS Hybrid Mode Example**

AT+FSB=(1 - 8)
(AT+PN=0) sets the SyncWord to 0x12
(AT+JD=1) sets Join Delay to 1 seconds
Downlink channel is (uplink_channel / 8)
OK

**AT+JBO Join Byte Order**

*Deprecated*

Sets the byte order (LSB or MSB first) in which the device EUI is sent to the gateway in a join request.

**Note:** Used only for connecting to non-compliant network servers.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+JBO=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+JBO</td>
</tr>
<tr>
<td>AT+JBO?</td>
</tr>
<tr>
<td>AT+JBO=?</td>
</tr>
</tbody>
</table>
Parameters and Values

Parameter1

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>LSB first (Default)</td>
</tr>
<tr>
<td>1</td>
<td>MSB first</td>
</tr>
</tbody>
</table>

Command with Response Examples

AT+JBO=0

OK

AT+JBO?

0

OK

help AT+JBO

AT+JBO: Send EUI's in join request with configured byte ordering (0:LSB,1:MSB)

OK

AT+JBO=?

AT+JBO: (0:LSB,1:MSB)

OK

AT+NJM Network Join Mode

Controls how the end device establishes communications with the gateway.

- When AT+NJM=2 (AUTO_OTA) and AT+PS is set to 1 the session is not be defaulted on reset or power.
- When AT+NJM=1 (OTA) AT+PS will not be applied and session stays in flash in either case.

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+NJM=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+NJM</td>
</tr>
<tr>
<td>AT+NJM</td>
</tr>
<tr>
<td>AT+NJM=?</td>
</tr>
</tbody>
</table>

Parameters and Values

Parameter1

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Manual configuration</td>
</tr>
<tr>
<td>1</td>
<td>OTA network join (Default)</td>
</tr>
</tbody>
</table>
Auto OTA network join on start up

**CAUTION:** Setting +NJM=2 causes the Dot to join immediately. Configure network settings and OTA mode before setting to AUTO OTA mode.

Peer-to-peer mode

**Command with Response Examples**

```
AT+NJM=1
OK

AT+NJM?
1
OK

help AT+NJM
AT+NJM: 0: Manual configuration, 1: OTA Network Join, 2: Auto OTA Network Join on start up, 3: Peer-to-Peer (default: 1)
OK

AT+NJM=?
AT+NJM: (0-3)
OK
```
**AT+JOIN  Join Network**  
Join network. For US915 and EU868 models +NI, +NK must match gateway settings in order to join. US915 must also match +FSB setting.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+JOIN</td>
</tr>
<tr>
<td>help AT+JOIN</td>
</tr>
<tr>
<td>AT+JOIN=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None

If Parameter1 is set to 1, a character string up to 128 characters.

**Error Messages**

- Failed to join network – No join response received from gateway.
- Join backoff – End device must wait for next available free channel to join. Issue AT+TXN to get the wait time.

**Command with Response Examples**

AT+JOIN
Successfully joined network

OK

AT+JOIN
Join Error - Failed to join network

ERROR

AT+JOIN
Join Error - Join backoff

ERROR

help AT+JOIN
AT+JOIN: Join network, provide argument of '1' to force join (acquire network address and session keys)

OK

AT+JOIN=?
AT+JOIN: (force:1)

OK
**AT+JR   Join Retries**

Enabling this setting allows the dot to search each sub-band when trying to join the Conduit when in AUTO OTA mode. The dot can then recover if the Conduit changes sub-band after it detects the lost network connection with AT+LCT used with AT+LCC or AT+ACK. The dot attempts to join on the configured AT+FSB the number of join retries, if unsuccessful it attempts on the next AT+FSB setting.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+JR=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+JR</td>
</tr>
<tr>
<td>AT+JR?</td>
</tr>
<tr>
<td>AT+JR=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1  
0 Disable  
1-255 Seconds enabled (Default is 2)

**Command with Response Examples**

AT+JR=5  
OK  
AT+JR?  
5  
OK  

help AT+JR  
AT+JR: US915 AUTO OTA Frequency sub-band search retries (0: disable, 1-255: attempts)  
OK  
AT+JR=?  
AT+JR: (0-255)  
OK

**AT+JD   Join Delay**

Allows the dot to use non-default join receive windows, if required by the network it is attempting to connect to. Initiating a join request opens a receive window to listen for the response. This command allows you to alter the default timing of the window.
**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+JD=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+JD</td>
</tr>
<tr>
<td>AT+JD?</td>
</tr>
<tr>
<td>AT+JD=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

1-15 seconds (Default is 5)

**Command with Response Examples**

AT+JD=1

OK

AT+JD?

1

OK

help AT+JD

AT+JD: Number of seconds before receive windows are opened for join (1 - 15)

OK

AT+JD=?

AT+JD: (1-15)

OK
Over-the-Air Activation (OTA)

LoRa allows OTA activation between a device and a network to generate session keys based on a pre-shared key. During OTA, the device exchanges Device and Network IDs with the server. If the Network ID matches the server’s configuration, session keys are generated using the pre-shared keys and random nonce values from the device and server. Then, a join accept message is sent to the device with the server’s random nonce value encrypted with the pre-shared key. After this initial exchange, only session keys are used for subsequent message encryption.

To use OTA, configure the network ID and network key and enable encryption.

AT+NI     Network ID

Configures network EUI, Name, or AppEUI/Join EUI. (App EUI in LoRaMac.) If AppEUI/JoinEUI is set then this value will be used as the default AT+NI setting when AT&F is issued.

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+NI=&lt;parameter1&gt;,&lt;parameter2&gt;</td>
</tr>
<tr>
<td>help AT+NI</td>
</tr>
<tr>
<td>AT+NI?</td>
</tr>
<tr>
<td>AT+NI=?</td>
</tr>
</tbody>
</table>

Parameters and Values

Parameter1

0   Second parameter is a hex key.
1   Second parameter is a string up to 128 characters long.
2   Second parameter is a hex key (set the AppEUI/JoinEUI).

Parameter2

16 bytes of hex data.
If Parameter1 is set to 1, a character string up to 128 characters.

Command with Response Examples

AT+NI=0,00:11:22:33:44:55:66:77
Set Network ID: 00.11.22.33.44.55.66.77

OK

AT+NI?

OK

AT+NI=1,This string can be up to 128 characters long.
Set Network Name: This string can be up to 128 characters long.

OK
AT+NI=2,cd-d7-15-e5-2b-dd-a6-27
Set Protected AppEUI: cd-d7-15-e5-2b-dd-a6-27
OK

AT+NI?
61-63-4d-b3-8a-2b-86-22
Passphrase: 'This string can be up to 128 characters long.'
OK

help AT+NI
AT+NI: Configured Network EUI/Name (App EUI in LoRaMac) AT+NI=0,hex
AT+NI=1, network_name (Net ID = crc64(network_name)) (8 bytes)
OK

AT+NI=?
AT+NI: (0,(hex:8)),(1,(string:128))
OK

**AT+NK Network Key**

Configures network key/passphrase. (App key in LoRaMac). Also, you can set the default AppKey, and if set, this will be used as the default AT+NK setting when AT&F is issued.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+NK=&lt;parameter1&gt;,&lt;parameter2&gt;</td>
</tr>
<tr>
<td>help AT+NK</td>
</tr>
<tr>
<td>AT+NK?</td>
</tr>
<tr>
<td>AT+NK=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

**Parameter1**

- 0  Second parameter is a hex key.
- 1  Second parameter is a string up to 128 characters long.
- 2  Second parameter is a hex key (set default AppKey).

**Parameter2**

- 16 bytes of hex data.
  
  If Parameter1 is set to 1, a character string up to 128 characters.
Command with Response Examples

Set Network Key: 88.99.aa.bb.cc.dd.ee.ff.00.11.22.33.44.55.66.77
OK

AT+NK?
88.99.aa.bb.cc.dd.ee.ff.00.11.22.33.44.55.66.77
OK

AT+NK=1,This String can be up to 128 characters long.
Set Network Passphrase: This String can be up to 128 characters long.
OK

AT+NK=2,bc.0b.bb.99.9b.17.4c.36.38.8c.0f.cf.ea.68.f3.f8
Set Protected AppKey: bc.0b.bb.99.9b.17.4c.36.38.8c.0f.cf.ea.68.f3.f8
OK

AT+NK?
e1.07.15.95.06.50.46.80.89.cf.2e.6e.2b.ea.f9.cf
Passphrase: 'This String can be up to 128 characters long.'
OK

help AT+NK
AT+NK: Configured network key/passphrase (App Key in LoraMac) ## AT+NK=0,hex
AT+NK=1,passphrase (Net key = cmac(passphrase)) (16 bytes)
OK

AT+NK=?
AT+NK: (0,(hex:16)),(1,(string:128))
OK

**AT+ENC  AES Encryption**

Enables or disables AES encryption of payload data.

**Note:** Must be enabled for use with nearly all network servers.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ENC=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+ENC</td>
</tr>
</tbody>
</table>
### Command

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ENC?</td>
</tr>
<tr>
<td>AT+ENC=?</td>
</tr>
</tbody>
</table>

### Parameters and Values

<table>
<thead>
<tr>
<th>Parameter1</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Disabled</td>
</tr>
<tr>
<td>1</td>
<td>Enabled  (Default)</td>
</tr>
</tbody>
</table>

### Command with Response Examples

AT+ENC=1

OK

AT+ENC?
1

OK

help AT+ENC
AT+ENC: Enable/disable AES encryption (0: off, 1: on)

OK

AT+ENC=?
AT+ENC: (0,1)

OK

### Manual Activation

If supported by the network server, the Dot can be activated manually. To do this, configure the network address, network session key, and data session key.

### AT+NA  Network Address

Sets network address in MANUAL join mode, the server will assign an address in OTA modes. (Supports modifying 8 multicast sessions, which can be saved and restored using AT+SS/AT+RS).

**Note**: There are two options for this command using either one or two parameters. For unicast, use one parameter (parameter1) to set or return the unicast value. For multicast, use two parameters (parameter1, parameter2) to set or return the multicast value (where parameter1 is the multicast session number and parameter2 is the multicast value).

### Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+NA=&lt;parameter1&gt;,&lt;parameter2&gt;</td>
</tr>
</tbody>
</table>
**Command**

| help AT+NA |
| AT+NA=<parameter1>,? |
| AT+NA=? |

**Parameters and Values**

Parameter1

For unicast: 4 bytes of hex data OR For multicast: Number of Multicast session [1-8]

Parameter2

For multicast only: 4 bytes of hex data.

**Command with Response Examples**

AT+NA= 1,01:fa:b0:1c
Set Network Address: 01:fa:b0:1c

OK

AT+NA=1,?
01:fa:b0:1c

OK

help AT+NA
AT+NA: Network address (devAddr in LoraMac) (4 bytes)

OK

AT+NA=?
AT+NA: (hex:4) or (1-8),(hex:4)

OK

**AT+NSK  Network Session Key**

Sets network session key in MANUAL join mode, will be automatically set in OTA modes. Also supports modifying multicast sessions.

**Note:** There are two options for this command using either one or two parameters. For unicast, use one parameter (parameter1) to set or return the unicast value. For multicast, use two parameters (parameter1, parameter2) to set or return the multicast value (where parameter1 is the multicast session number and parameter2 is the multicast value).

**Syntax**

| Command |
| AT+NSK=<parameter1>, <parameter2> |
**Command**

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>help AT+NSK</td>
<td>Show help for the command</td>
</tr>
<tr>
<td>AT+NSK=&lt;parameter1&gt;,?</td>
<td>Set or return the unicast value</td>
</tr>
<tr>
<td>AT+NSK=?</td>
<td>Show all command parameters</td>
</tr>
</tbody>
</table>

**Parameters and Values**

**Parameter1**
- For unicast, 16 bytes of hex data **OR** For multicast, Number of Multicast session [1-8].

**Parameter2**
- For multicast only, 16 bytes of hex data.

**Command with Response Examples**

```
Set Network Session Key: 00.11.22.33.44.55.66.77.88.99.aa.bb.cc.dd.ee.ff
OK
```

```
AT+NSK=1,?
00.11.22.33.44.55.66.77.88.99.aa.bb.cc.dd.ee.ff
OK
```

```
help AT+NSK
AT+NSK: Network session encryption key (16 bytes)
OK
```

```
AT+NSK=?
AT+NSK: (hex:16) or (1-8), (hex:16)
OK
```

**AT+DSK Data Session Key**

Sets data session key in MANUAL join mode, will be automatically set in OTA modes. Used for AES-128 encryption of transferred data. Supports modifying multicast sessions.

**Note:** There are two options for this command using either one or two parameters. For unicast, use one parameter (parameter1) to set or return the unicast value. For multicast, use two parameters (parameter1, parameter2) to set or return the multicast value (where parameter1 is the multicast session number and parameter2 is the multicast value).

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+DSK=&lt;parameter1&gt;, &lt;parameter2&gt;</td>
<td>Set or return the data session key</td>
</tr>
</tbody>
</table>
### Command

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>help AT+DSK</td>
</tr>
<tr>
<td>AT+DSK=&lt;parameter1&gt;, ?</td>
</tr>
<tr>
<td>AT+DSK= ?</td>
</tr>
</tbody>
</table>

### Parameters and Values

**Parameter1**

For unicast, 16 bytes of hex data **OR** for multicast, Number of Multicast session [1-8]

**Parameter2**

For multicast only, 16 bytes of hex data.

### Command with Response Examples


Set Multicast Application Session Key 1:

ff.ee.dd.cc.bb.aa.99.88.77.66.55.44.33.22.11.00

OK

**AT+DSK=1,?**

ff.ee.dd.cc.bb.aa.99.88.77.66.55.44.33.22.11.00

OK

Help AT+DSK

AT+DSK: Data session encryption key (16 bytes)

OK

**AT+DSK=?**

AT+DSK: (hex:16) or (1-8),(hex:16)

OK

### AT+ULC Uplink Counter

A device using MANUAL join mode a network server may reject uplink packets, if they do not have the correct counter value. This setting is available for an application to manage this session parameter. Otherwise, use AT+SS and AT+RS to save this setting to flash in any join mode.

### Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ULC=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+ULC</td>
</tr>
<tr>
<td>AT+ULC?</td>
</tr>
</tbody>
</table>
**Command**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ULC=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

0-4294967295 (Default is 1).

**Command with Response Examples**

```
AT+ULC=1
OK

AT+ULC?
1
OK

help AT+ULC
AT+ULC: Get or set the uplink counter for the next packet
OK

AT+ULC=?
AT+ULC: (0-4294967295)
OK
```

**AT+DLC   Downlink Counter**

A device using MANUAL join mode, it may reject downlink packets if they do not have the correct counter value. This setting is available for an application to manage this session parameter. Otherwise, use AT+SS and AT+RS to save this setting to flash in any join mode. Also, supports modifying multicast sessions.

**Note:** There are two options for this command using either one or two parameters. For unicast, use one parameter (parameter1) to set or return the unicast value. For multicast, use two parameters (parameter1, parameter2) to set or return the multicast value (where parameter1 is the multicast session number and parameter2 is the multicast value).

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+DLC=&lt;parameter1&gt;,&lt;parameter2&gt;</td>
</tr>
<tr>
<td>help AT+DLC</td>
</tr>
<tr>
<td>AT+DLC=?</td>
</tr>
<tr>
<td>AT+DLC=&lt;parameter1&gt;,?</td>
</tr>
</tbody>
</table>
Parameters and Values

Parameter1
For Unicast, Value of the Downlink Counter, a 32-bit unassigned integer with a range of 0-4294967295 (Default is 1) OR For Multicast, Number of the Multicast session [1-8].

Parameter2
For Multicast only, Value of the Downlink Counter, a 32-bit unassigned integer with a range of 0-4294967295 (Default is 1).

Command with Response Examples

AT+DLC=1,1
Sets the downlink counter of session #1
OK

AT+DLC=1,?
1
OK

help AT+DLC
AT+DLC: Get or set the downlink counter
OK

AT+DLC=?
AT+DLC: (0-4294967295) or (1-8),(0-4294967295)
OK

AT+GK Generic App Key
Set generic app key for multicast McKEKey derivation.

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+GK</td>
</tr>
<tr>
<td>AT+GK=&lt;parameter 1&gt;</td>
</tr>
<tr>
<td>help AT+GK</td>
</tr>
</tbody>
</table>

Parameters and Values

Parameter1
Gen App Key (hex:16)

Command with Response Examples

AT+GK
Network Joining

OTA Network Join

After configuring the network ID and network key on the mDot, send a join packet with the device ID, network ID, and a dev-nonce value. The network server checks the network ID and assigns an address, which is returned with the network ID and app-nonce value. Session keys are generated independently on the device and network server using the network address, network ID, nonce-values, and network key.

- AT+NJM=1 Configure mDot for OTA join mode (default).
- AT+JOIN Send a join request to the server.
- AT+NJS Display current join status 0:not joined, 1:joined.

Auto OTA Network Join

After a successful join, the session information is stored in flash. This session information is restored when waking from sleep. If the device is reset or the power cycled, session information is reset and a join is attempted. The session information is valid as long as the Dot checks in before the Conduit’s lease-time expires.

- AT+NJM=2 Configure Dot for AUTO OTA join mode.
- AT+JOIN Reloads the session info from flash.
- AT+JOIN=1 Force Dot to perform OTA join regardless for saved session.

Ensuring Network Connectivity

AT+NJS Network Join Status

Displays the last known network join state, which helps determine if communication has been lost. Join status is also available on Associate Pin (mDot:A2, xDot:GPIO0).

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+NJS=&lt;parameter1&gt;</td>
</tr>
</tbody>
</table>

help AT+NJS
### Command

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+NJS?</td>
</tr>
<tr>
<td>AT+NJS=?</td>
</tr>
</tbody>
</table>

#### Parameters and Values

<table>
<thead>
<tr>
<th>Parameter1</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Not joined.</td>
</tr>
<tr>
<td>1</td>
<td>Joined</td>
</tr>
</tbody>
</table>

#### Command with Response Examples

```plaintext
AT+NJS
0
OK

AT+NJS?
0
OK

help AT+NJS
AT+NJS: 0: Not joined, 1: Joined
OK

AT+NJS=?
AT+NJS: (0,1)
OK
```

### Pin Output

Join status is also available on Associate Pin (mDot:A2, xDot:GPIO0).

### AT+JN Join Nonces

Sets OTA Join Nonce. Join Dev Nonce increments with each Join Request sent. Join App Nonce is validated to increment with each Join Accept received. Both are reset to 0 when the NetworkID/AppEUI changes.

#### Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+JN</td>
</tr>
<tr>
<td>AT+JN=&lt;parameter1&gt;,&lt;parameter2&gt;</td>
</tr>
<tr>
<td>help AT+JN</td>
</tr>
<tr>
<td>AT+JN?</td>
</tr>
<tr>
<td>AT+JN=?</td>
</tr>
</tbody>
</table>
Parameters and Values

Parameter1
Dev Nonce (0-65535)

Parameter2
App Nonce (0-16777215)

Command with Response Examples

AT+JN
1,1
OK

AT+JN=2,2
OK

AT+JN?
2,2
OK

help AT+JN
AT+JN: Set OTA Join Nonce
OK

AT+JN=7?
AT+JN: (0-65535), (0-16777215)
OK

AT+JNV   Enable Join Nonce Validation

Enable or disable join app nonce validation in join accept from network. Default is enabled (1). Disable value is 0. NOTE: If you use disjoint join servers (multiple independent Conduits), then you will need a Lens Join Sever to ensure the join nonce counter works.

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+JNV</td>
</tr>
<tr>
<td>AT+JNV=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+JNV</td>
</tr>
<tr>
<td>AT+JNV=?</td>
</tr>
</tbody>
</table>
Parameters and Values

Parameter1
Disable or Enable (0, 1) Default is 1, enabled

Command with Response Examples

AT+JNV
1
OK
AT+JNV=0
OK
help AT+JNV
AT+JNV: Enable/disable join nonce validation
OK
AT+JNV=?
AT+JNV: (0,1)
OK

AT+PING  Send Ping

Sends a ping to the gateway. The gateway responds with a pong containing RSSI and SNR, which the end device displays. RSSI ranges from -140dB to –0dB and SNR ranges from -20dBm to 20dBm.

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+PING</td>
</tr>
<tr>
<td>help AT+PING</td>
</tr>
<tr>
<td>AT+PING=?</td>
</tr>
</tbody>
</table>

Parameters and Values

None

Command with Response Examples

AT+PING
-31,10.0
OK
AT+PING
Network Not Joined
ERROR

help AT+PING
AT+PING: Sends ping and displays the servers received rssi and snr
OK

AT+PING=?
AT+PING: (-140-0),(-20.0-20.0)
OK

**AT+ACK Require Acknowledgment**
The maximum number of times the end device tries to retransmit an unacknowledged packet. Options are from 1 to 15.

**Note:** When ACKs are enabled, the AT+SEND command does not return until the ACK is received or attempts are exhausted.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ACK=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+ACK</td>
</tr>
<tr>
<td>AT+ACK?</td>
</tr>
<tr>
<td>AT+ACK=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

- 0: ACKs are not required. (Default)
- 1-15: The maximum number of attempts without an acknowledgment.

**Command with Response Examples**

AT+ACK=0

OK

AT+ACK?

0

OK

help AT+ACK
AT+ACK: Enable to require send acknowledgment (0: off, N: number of attempts until ACK received)
OK

AT+ACK=?
AT+ACK: (0-15)

OK

**AT+NLC  Network Link Check**

Performs a network link check. The first number in the response is the dBm level above the demodulation floor (not to be confused with the noise floor). This value is from the perspective of the signal sent from the end device and received by the gateway. The second number is the count of gateways reporting the link-check request to the network server.

When the network link check is performed, an empty packet is sent to the gateway and the network server may include a downlink payload with the command answer. If a payload is included it displays on the next line. The AT+RXO setting determines payload format.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+NLC</td>
<td>Network Link Check</td>
</tr>
<tr>
<td>help AT+NLC</td>
<td>Request help on AT+NLC command</td>
</tr>
<tr>
<td>AT+NLC?</td>
<td>Display help on AT+NLC command</td>
</tr>
<tr>
<td>AT+NLC=?</td>
<td>Request help on AT+NLC command</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None

**Command with Response Examples**

AT+NLC
11, 2

OK

AT+NLC
No response from network

ERROR

AT+NLC
Network Not Joined

ERROR

AT+NLC
26, 1
40
help AT+NLC
AT+NLC: Perform network link check, displays dBm above floor, number of gateways in range and optional packet payload if received

OK

AT+NLC=?
AT+NLC: (-20.0-20.0),(1-)

OK

**AT+LCC Link Check Count**

Performs periodic connectivity checking. This feature is an alternative to enabling ACK for all packets in order to detect when the network is not available or the session information has been reset on the server.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+LCC=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+LCC</td>
</tr>
<tr>
<td>AT+LCC?</td>
</tr>
<tr>
<td>AT+LCC=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter 1

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Disabled (Default)</td>
</tr>
<tr>
<td>1-255</td>
<td>Number of packets sent before a link check is performed. Link checks are not be sent if ACKs are enabled.</td>
</tr>
</tbody>
</table>

**Command with Response Examples**

AT+LCC=3

OK

AT+LCC?

3

OK

help AT+LCC

AT+LCC: Set number of packets between each link check if ACK's are disabled

OK
AT+LCC=?
AT+LCC: (0:off,N:Packets (max 255))

OK

**AT+LCT  Link Check Threshold**

Threshold for the number of consecutive link check or ACK failures to tolerate before setting the join status to not joined.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+LCT=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+LCT</td>
</tr>
<tr>
<td>AT+LCT?</td>
</tr>
<tr>
<td>AT+LCT=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

<table>
<thead>
<tr>
<th>0</th>
<th>Disabled (Default)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-255</td>
<td>Number of failures before not joined status is set</td>
</tr>
</tbody>
</table>

**Command with Response Examples**

AT+LCT=3

OK

AT+LCT?

3

OK

help AT+LCT

AT+LCT: Set threshold for number of link check or ACK failures to tolerate, (0: off, N: number of failures)

OK

AT+LCT=?

AT+LCT: (0-255)

OK

**AT+BTO  Class B Timeout**

Set the timeout the network expects to receive an ACK for a confirmed downlink received in a Class B window.
**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+BTO=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+BTO</td>
</tr>
<tr>
<td>AT+BTO=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter 1  Timeout period from 0-120 seconds. (Default is 8).

**Command with Response Examples (for setup of a Class B device)**

AT+BTO=10

OK

help AT+BTO
AT+BTO: Set Class B timeout (0-120 seconds)

OK

**AT+CTO  Class C Timeout**

Set the timeout the network expects to receive an ACK for a confirmed downlink received in a Class C window.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CTO=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+CTO</td>
</tr>
<tr>
<td>AT+CTO=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter 1  Timeout period from 0-120 seconds. (Default is 8).

**Command with Response Examples (for setup of a Class C device)**

AT+CTO=10

OK

help AT+CTO
AT+CTO: Set Class C timeout (0-120 seconds)

OK
Preserving, Saving, and Restoring Sessions

**AT+SS  Save Network Session**

Saves the network session information (join) over resets allowing for a session restore (AT+RS) without requiring a join. This command should be issued after the Dot has joined. See AT+PS if using auto join mode.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+SS</td>
</tr>
<tr>
<td>help AT+SS</td>
</tr>
<tr>
<td>AT+SS?</td>
</tr>
<tr>
<td>AT+SS=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None

**Command with Response Examples**

```
AT+SS
OK

help AT+SS
AT+SS: Save network session info to flash
OK

AT+SS=?
AT+SS: NONE
OK
```

**AT+RS  Restore Network Session**

Restores the network session information (join) that was saved with the AT+SS command.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+RS</td>
</tr>
<tr>
<td>help AT+RS</td>
</tr>
<tr>
<td>AT+RS?</td>
</tr>
<tr>
<td>AT+RS=?</td>
</tr>
</tbody>
</table>
Parameters and Values

None

Command with Response Examples

AT+RS
OK

HELP AT+RS
AT+RS: Restore network session info from flash
OK

AT+RS=?
AT+RS: NONE
OK

**AT+PS  Preserve Session**

Preserves the network session information over resets when using auto join mode (AT+NJM). If not using auto join mode, use with the save session command (AT+SS).

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+PS=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+PS</td>
</tr>
<tr>
<td>AT+PS?</td>
</tr>
<tr>
<td>AT+PS=?</td>
</tr>
</tbody>
</table>

Parameters and Values

Parameter1

<table>
<thead>
<tr>
<th>0</th>
<th>Off (Default)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>On</td>
</tr>
</tbody>
</table>

Command with Response Examples

AT+PS=0
OK

AT+PS?
0
OK
help AT+PS
AT+PS: Save network session info through reset or power down in AUTO_OTA mode (0:off, 1:on)
OK

AT+PS=?
AT+PS: (0,1)
OK

**AT&WP Save Protected Settings**

Saves protected settings available in all firmware. This command creates a write protected configuration to flash (DevEUI, AppEUI, AppKey, and Frequency Band)

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT&amp;WP</td>
</tr>
<tr>
<td>help AT&amp;WP</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None

**Command with Response Examples**

AT&WP
OK

help AT&WP

AT&WP: Write protected config to flash (DevEUI, AppEUI, AppKey, Frequency Band)
OK
Chapter 4 – Sending and Receiving Packets

Channels and Duty Cycles

For reference, use the +TXCH command to display channels used with frequency hopping.

**Note:** Europe 868 MHz deployments have a 1% duty cycle, meaning your devices can be on air only 1% of the time per hour. This limitation is part of the European radiated emission requirements and cannot be avoided or changed. Sending more data than the air time allows results in a transmit error - no free channel debug notice.

**AT+CHM Channel Mask**

Sets a channel mask to enable or disable channels to be used to transmit packets.

- **US915/AU915** — 72 bit mask (MSB)
- **EU868** — 16 bit mask (MSB)

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CHM=&lt;parameter1&gt;,&lt;parameter2&gt;</td>
</tr>
<tr>
<td>help AT+CHM</td>
</tr>
<tr>
<td>AT+CHM?</td>
</tr>
<tr>
<td>AT+CHM=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

**US915/AU915**

Parameter1,Parameter2

- 0,00FF Enables channels 0-7, disables channels 8-15
- 0,FFFF Enables channels 0-15
- 2,00FF Enables channels 32-39, disables channels 40-47
- 4,00FF Enables channels 64-71

**EU868**

Parameter1,Parameter2

- 0,000F Enables default channels 0-3, disables channels 4-15

**Command with Response Examples**

```
help AT+CHM
AT+CHM: Get/set channel mask (OFFSET:0-4,MASK:0000-FFFF)
OK

US915
AT+FSB=0
```
OK

AT+CHM
0FF00000000000000FF

OK

AT+FSB=1

OK

AT+CHM
0010000000000000FF

OK

AT+FSB=2

OK

AT+CHM
0020000000000000FF00

OK

**EU868**

AT+CHM=0,00FF

OK

AT+CHM
00FF

OK

**AT+TXCH** Transmit Channel

With an US 951MHz model, lists the available channels in the current AT+FSB setting

With an EU 868MHz model, lists the available channels, including additional channels sent by the network server with the JoinAccept message. With an EU 868MHz model, this command can be used to add additional channels

**EU868 Adding a Channel**

AT+TXCH=<INDEX>,<FREQUENCY>,<RANGE> INDEX - 3-15 FREQUENCY - 863000000-870000000 RANGE - datarate range

For example, 40 -> DR4:max DR0:min, 77 -> DR7:max DR7:min
**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+TXCH</td>
</tr>
<tr>
<td>help AT+TXCH</td>
</tr>
<tr>
<td>AT+TXCH?</td>
</tr>
<tr>
<td>AT+TXCH=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None

**Command with Response Examples**

AT+FSB=1

OK

AT+TXCH

<table>
<thead>
<tr>
<th>Index</th>
<th>Frequency</th>
<th>DR</th>
<th>Max</th>
<th>Min</th>
<th>On</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>9023000000</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>9025000000</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>9027000000</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>9029000000</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>9031000000</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>9033000000</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>9035000000</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>9037000000</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>U</td>
<td>9030000000</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>9233000000</td>
<td>8</td>
<td>8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

OK

AT+FSB=1

OK

AT+TXCH

<table>
<thead>
<tr>
<th>Index</th>
<th>Frequency</th>
<th>DR</th>
<th>Max</th>
<th>Min</th>
<th>On</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>9023000000</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>9025000000</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>9027000000</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>9029000000</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>9031000000</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>9033000000</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>9035000000</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>9037000000</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>U</td>
<td>9030000000</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
R2  923300000  8  8
OK

help AT+TXCH
AT+TXCH: List Tx channel frequencies for sub-band
OK

AT+TXCH=?
AT+TXCH: TABLE
OK

Note the following for US915:

- U : Uplink Channel for DR4:SF8BW500
- R2 : Frequency and datarate for second receive window
- In public mode, R2 defaults to 923.3 DR8
- In private mode, R2 is defaulted by AT+FSB setting 1:923.3,2:923.9,...

Add EU868 FSK Channel at Index 8

AT+TXCH=8,868800000,77
OK

EU868 Before Join

<table>
<thead>
<tr>
<th>Index</th>
<th>Frequency</th>
<th>DR</th>
<th>Max</th>
<th>Min</th>
<th>On</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>868100000</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>868300000</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>868500000</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
EU868 After Join

AT+TXCH

Index | Frequency | DR | Max | Min | On
--- | --- | --- | --- | --- | ---
0 | 868100000 | 5 | 0 | 1 | 
1 | 868300000 | 6 | 0 | 1 | 
2 | 868500000 | 5 | 0 | 1 | 
3 | 866100000 | 5 | 0 | 1 | 
4 | 866300000 | 5 | 0 | 1 | 
5 | 866500000 | 5 | 0 | 1 | 
6 | 866700000 | 5 | 0 | 1 | 
7 | 866900000 | 5 | 0 | 1 | 
8 | 0 | 0 | 0 | 0 | 
9 | 0 | 0 | 0 | 0 | 
10 | 0 | 0 | 0 | 0 | 
11 | 0 | 0 | 0 | 0 | 
12 | 0 | 0 | 0 | 0 | 
13 | 0 | 0 | 0 | 0 | 
14 | 0 | 0 | 0 | 0 | 
15 | 0 | 0 | 0 | 0 | 
R2 | 869525000 | 0 | 0 | 

AT+LBT  Listen Before Talk

Enables or disables the Listen Before Talk function.

Syntax

**Command**

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+LBT=&lt;parameter1&gt;,&lt;parameter2&gt;</td>
<td></td>
</tr>
<tr>
<td>help AT+LBT</td>
<td></td>
</tr>
<tr>
<td>AT+LBT?</td>
<td></td>
</tr>
<tr>
<td>AT+LBT=?</td>
<td></td>
</tr>
</tbody>
</table>

**Parameters and Values**

**Parameter1**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Disable</td>
</tr>
<tr>
<td>0-65535</td>
<td>Time for the listen before talk delay in microseconds (μs).</td>
</tr>
</tbody>
</table>

**Parameter2**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Disable</td>
</tr>
<tr>
<td>-127-128 dBm</td>
<td>Threshold</td>
</tr>
</tbody>
</table>
Command with Response Examples

AT+LBT=?
AT+LBT: time(0-65535 us), threshold(-127-128 dBm) (0,0: disable, time, threshold: enable)

OK

Get current LBT configuration: 0,0 means it is disabled:
AT+LBT
0,0

OK

Set LBT to -65dB threshold and 5ms sample time:
AT+LBT=5000,-65

OK

Verify configuration:
AT+LBT
5000,-65

OK

These settings also appear in the AT&V results.

**AT+TXN Transmit Next**

Returns the time, in milliseconds, until the next free channel is available to transmit data. The time can range from 0-2793000 milliseconds.

EU868 time to wait may be duty-cycle limit on channel or network imposed Join duty-cycle. US915 will only be affected by the network imposed Join duty-cycle.

Network imposed join duty-cycle in LoRaWAN 1.0.1:

| 1.0% | 0-1 hour |
| 0.1% | 1-10 hours |
| 0.01% | 10+ hours |

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+TXN</td>
</tr>
<tr>
<td>help AT+TXN</td>
</tr>
<tr>
<td>AT+TXN?</td>
</tr>
<tr>
<td>AT+TXN=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None
Command with Response Examples

AT+TXN
0
OK

AT+TXN?
0
OK

help AT+TXN
AT+TXN: Get time in ms until next free channel
OK

AT+TXN=?
AT+TXN: (0-2793000)
OK

AT+TOA   Time On Air
Displays the amount of on air time, in milliseconds, required to transmit the number of bytes specified at the current data rate. (Included for informational purposes.)

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+TOA=&lt;parameter1&gt;</td>
</tr>
</tbody>
</table>

help AT+TOA
AT+TOA?
AT+TOA=?

Parameters and Values

Parameter1

0-242 The number of bytes used to calculate the time on air.

Command with Response Examples

AT+TOA=128
738
OK

AT+TOA?
Invalid parameter, expects (0-242)
ERROR

help AT+TOA
AT+TOA: Get time in ms of packet tx with current datarate
OK

AT+TOA=?
AT+TOA: (0–242)
OK

**AT+FO**  **Frequency Offset**

Used to adjust TX frequency offset.

**Syntax**

**Command**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+FO=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+FO</td>
</tr>
<tr>
<td>AT+FO?</td>
</tr>
<tr>
<td>AT+FO=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

**Parameter1**

Transmit frequency offset in Hz (-32768,32768)

**Command with Response Examples**

AT+FO
0
OK

AT+FO=5000
OK

AT+FO
5000
OK
Configuring

**AT+MAC Inject MAC Command**

When used without a parameter the MAC command buffer to be sent with the next packet is displayed. The MAC command buffer can be cleared by passing an argument of '0'. Changes made by MAC commands through this command or made by the server can be saved with AT+SS and restored with AT+RS.

- **LinkADRReq**: If ADR is enabled, changes device's datarate and power. Changes the channel mask and redundancy regardless of ADR setting.
- **DutyCycleReq**: Sets device's total time on air duty cycle.
- **RxParamSetupReq**: Changes downlink frequency and datarates.
- **DevStatus**: Requests the device’s status, battery, and RX packet SNR value.
- **NewChannelReq**: Requests the device to add or delete a channel.
- **RxTimingSetup**: Changes the delay from end of TX to opening of RX1.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+MAC=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+MAC</td>
</tr>
<tr>
<td>AT+MAC?</td>
</tr>
<tr>
<td>AT+MAC=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

**Parameter1**

**LinkADRReq**

Format: ID (1) | DR_PWR (1) | MASK (2) | CTRL_REP (1)

Example: 0350FF0001 -> DR: 5 PWR: 0 MASK: FF00 CTRL: 0 REP: 1

- **ID**: MAC command ID
- **DR**: Datarate index US915 0-4, AU915 0-4, EU868 0-7
- **PWR**: Power index US915 0-10, AU915 0-10, EU868 0-5
- **MASK**: 16 bit mask for enabling channels
- **CTRL**: Instructions for applying the 16-bit mask field
- **REP**: Redundancy setting to repeat a packet unless downlink is received

**DutyCycleReq**

Format: ID (1) | MDC (1)

ID: MAC command ID

**MDC**: MAX_DUTY_CYCLE (MDC) – duty cycle setting ( 1 / 2^MDC )

Values:

<table>
<thead>
<tr>
<th>MDC</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0400</td>
<td>100%</td>
</tr>
<tr>
<td>0401</td>
<td>50%</td>
</tr>
<tr>
<td>040F</td>
<td>0.003%</td>
</tr>
</tbody>
</table>
RxParamSetupReq  Format: ID (1) | DLSettings (1) | Frequency (3)
Example: 050468E28C ? RX1O: 0 RX2: 5 FREQ: 923300000
ID          MAC command ID
DLSettings  Datarate offset for RX1 and datarate index for RX2
Frequency   3 bytes of frequency in 100 Hz (LSB)

DevStatus   Format: ID (1)
Example: 06
ID          MAC command ID

NewChannelReq Format: ID (1) | INDEX (1) | FREQ (3) | RANGE (1)
Example: 0703F87D8440 -> INDEX: 3 FREQ: 868300000 RANGE: MAX:4 MIN:0
ID          MAC command ID
INDEX       Channel Index
FREQ        Channel frequency in 100 Hz
RANGE       Datarate range (MAX:4,MIN:4)

RxTimingSetup Format: ID (1) | DELAY (1)
Example: 0801 ? DELAY: 1 second
ID          MAC command ID
Delay       Delay in seconds until RX1

**Command with Response Examples**

**Inject Device Status MAC Command**

AT+MAC=06

OK

**Show MAC Commands Buffer to be Sent in Next Packet**

AT+MAC
06ffee00

OK

**Clear MAC Commands Buffer to be Sent in Next Packet**

AT+MAC=0

OK

AT+MAC
OK
**Help**

help AT+MAC
AT+MAC: Inject MAC command to MAC layer or read uplink MAC command buffer, pass '0' argument to clear buffer

OK

**AT&V  Settings and Status**
Displays device settings and status in a tabular format.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AT&amp;V</td>
<td></td>
</tr>
<tr>
<td>help AT&amp;V</td>
<td></td>
</tr>
<tr>
<td>AT&amp;V=?</td>
<td></td>
</tr>
</tbody>
</table>

**Parameters and Values**

None

**Command with Response Examples**

AT&V

Device ID:  be:7a:00:00:00:00:07:7a
Default Frequency Band:  US915
Current Frequency Band:  US915
Frequency Sub Band:  0
Network Mode:  Public LoRaWAN
Start Up Mode:  COMMAND
Network Address:  00000000
Network ID Passphrase:
Network Key:  2b.7e.15.16.28.ae.d2.a6.ab.71.58.09.cf.4f.45
Network Key Passphrase:
Network Session Key:  00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00
Data Session Key:  00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00
Network Join Mode:  OTA
Network Join Retries:  2
Preserve Session: off
Join Byte Order: LSB
Join Delay: 1
Join Rx1 DR Offset 0
Join Rx2 Datarate: DR8 – SF12BW500
Join Rx2 Frequency: 923300000
App Port: 1
Listen Before Talk: off
Link Check Threshold: off
Link Check Count: off
Error Correction: 1 bytes
ACK Retries: off
Packet Repeat: 1
Encryption: on
CRC: on
Adaptive Data Rate: off
Command Echo: on
Verbose Response: off
Tx Frequency: 0
Tx Data Rate: DR0 – SF10BW125
Min/Max Tx Data Rate: Min: DR0 – SF10BW125
Max: DR4 – SF8BW500
Tx Power: 30
Min/Max Tx Power: 0
30
Tx Antenna Gain: 3
Tx Wait: on
Tx Inverted Signal: off
Rx Delay: 1 s
Rx Inverted Signal: on
Rx Output Style: HEXADECIMAL
Debug Baud Rate: 115200
Serial Baud Rate: 115200
Serial Flow Control: off
Serial Clear On Error: on
Wake Mode: INTERVAL
Wake Interval: 10 s
Wake Delay: 100 ms
Wake Timeout: 20 ms
Wake Pin: DI8
Log Level: 0

OK

help AT&V
AT&V: Displays current settings and status

OK
AT&V=?
AT&V: TABLE

OK

**AT+DC**  **Device Class**

Sets the device class. The LoRaWAN 1.0 specification defines the three device classes, Class A, B and C as follows:

- **Class A: Bi-directional End Devices** allow for bi-directional communications where each end device’s uplink transmission is followed by two short downlink receive windows. The transmission slot scheduled by the end device is based on its communication needs with a small variation based on a random time basis (ALOHA-type protocol). This Class A operation is the lowest power end device system for applications that only require downlink communication from the server shortly after the end device has sent an uplink transmission. Downlink communications from the server at any other time have to wait until the next scheduled uplink.

- **Class B: Bi-directional end devices with scheduled receive slots** allow for more receive slots. In addition to the Class A random receive windows, Class B devices open extra receive windows at scheduled times. For the end device to open a receive window as scheduled, it must receive a time synchronized beacon from the gateway. This allows the server to know when the end device is listening.

- **Class C: Bi-directional end devices with maximal receive slots** have nearly continuously open receive windows, which close only when transmitting. Class C end devices use more power to operate than Class A or Class B, but they offer the lowest latency for server to end device communication.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+DC=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+DC</td>
</tr>
<tr>
<td>AT+DC?</td>
</tr>
</tbody>
</table>
**SENDING AND RECEIVING PACKETS**

**Command**

<table>
<thead>
<tr>
<th>Command</th>
<th>AT+DC=?</th>
</tr>
</thead>
</table>

**Parameters and Values**

**Parameter1**

- **A**: Class A device. (Default)
- **B**: Class B device.
- **C**: Class C device. (Not supported in Version 2.0 or older.)

**Command with Response Examples**

AT+DC=A

OK

help AT+DC
AT+DC: Device class (A,B,C)

OK

AT+DC=?
AT+DC: (A,B,C)

OK

**AT+URC Unsolicited Response Code**

Enable or disable unsolicited response codes. When you enable Class B and C, downlinks are presented in the serial output. Use with AT+RXO=3 to set output to extended HEX with additional packet info, Type, Addr, FCNT, Port, Payload. If AT+RXO != 3 RECV is displayed and use AT+RECV to retrieve the packet.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
<th>AT+URC=&lt;parameter1&gt;</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Command</th>
<th>help AT+URC</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Command</th>
<th>AT+URC=?</th>
</tr>
</thead>
</table>

**Parameters and Values**

**Parameter1**

- Enable or disable (0: disable, 1: enable)

**Command with Response Examples**

AT+URC=0

OK
AT+URC=1
OK

help AT+URC
AT+URC: Output packets to terminal when received
OK

AT+URC=?
(0:disable,1:enable)
OK

**AT+AP Application Port**
Sets the port used for application data. Each LoRaWAN packet containing data has an associated port value. Port 0 is reserved for MAC commands, ports 1-223 are available for application use, and port 233-255 are reserved for future LoRaWAN use.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+AP=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+AP</td>
</tr>
<tr>
<td>AT+AP?</td>
</tr>
<tr>
<td>AT+AP=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1
1-223 The port used for application data.

**Command with Response Examples**

AT+AP=1
OK

AT+AP?
1
OK

HELP AT+AP
AT+AP: Port used for application data (1 - 223)
OK
AT+AP=?
AT+AP: (1-223)

OK

**AT+TXP**  **Transmit Power**

Configures the output power of the radio in dBm, before antenna gain. The mac layer will attempt to reach this output level but limit any transmission to the local regulations for the chosen frequency.

*Note:* Refer to AT+ANT to configure antenna gain.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+TXP=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+TXP</td>
</tr>
<tr>
<td>AT+TXP?</td>
</tr>
<tr>
<td>AT+TXP=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

0-20 dB. (Default is 11).

**Command with Response Examples**

AT+TXP=11

OK

AT+TXP?

11

OK

help AT+TXP

AT+TXP: Set the Tx power for all channels

OK

AT+TXP=?

AT+TXP: (0-20)

OK
**AT+TXI  Transmit Inverted**

**Deprecated**

Sets TX signal inverted.

*Note:* Transmitted signals are inverted so motes/gateways do not see other mote/gateway packets.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+TXI=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+TXI</td>
</tr>
<tr>
<td>AT+TXI?</td>
</tr>
<tr>
<td>AT+TXI=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

<table>
<thead>
<tr>
<th>Parameter1</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Not inverted (Default)</td>
</tr>
<tr>
<td>1</td>
<td>Inverted</td>
</tr>
</tbody>
</table>

**Command with Response Examples**

AT+TXI=0

OK

AT+TXI?

0

OK

help AT+TXI
AT+TXI: Set Tx signal inverted, (default:off)

OK

AT+TXI=?
AT+TXI: (0,1)

OK

**AT+RXI  Receive Signal Inverted**

**Deprecated**

Sets RX signal inverted.

*Note:* Transmitted signals are inverted so motes/gateways do not see other mote/gateway packets.
**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+RXI=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+RXI</td>
</tr>
<tr>
<td>AT+RXI?</td>
</tr>
<tr>
<td>AT+RXI=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

<table>
<thead>
<tr>
<th>0</th>
<th>Receive signal not inverted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Receive signal inverted (Default)</td>
</tr>
</tbody>
</table>

**Command with Response Examples**

AT+RXI=1

OK

AT+RXI?

1

OK

help AT+RXI

AT+RXI: Set Rx signal inverted, (default: on)

OK

AT+RXI=?

AT+RXI: (0,1)

OK

**AT+RXD Receive Delay**

Allows the dot to use non-default rx windows, if required by the network it is attempting to communicate with. Opens receive window to listen for a response when sending packets with one of the +SEND commands.

**Note:** Setting must match that of network server, in case of OTA join the value sent in Join Accept message overwrites this setting.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+RXD=&lt;parameter1&gt;</td>
</tr>
</tbody>
</table>
### Command

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>help AT+RXD</td>
</tr>
<tr>
<td>AT+RXD?</td>
</tr>
<tr>
<td>AT+RXD=?</td>
</tr>
</tbody>
</table>

#### Parameters and Values

- **Parameter1**
  - 1-15 seconds (Default)

### Command with Response Examples

- **AT+RXD=1**
  - OK
- **AT+RXD?**
  - 1
  - OK

- **help AT+RXD**
  - AT+RXD: Number of seconds before receive windows are opened (1 - 15)
  - OK
- **AT+RXD=?**
  - AT+RXD: (0,1)
  - OK

### AT+FEC  Forward Error Correction

**Deprecated**

Sends redundant data to compensate for unreliable communication with the goal of reducing the need to retransmit data. Increasing redundancy increases time-on-air, LoRaWAN specifies a setting of 1 (4/5).

#### Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+FEC=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+FEC</td>
</tr>
<tr>
<td>AT+FEC?</td>
</tr>
<tr>
<td>AT+FEC=?</td>
</tr>
</tbody>
</table>

#### Parameters and Values

- **Parameter1**
1 Sends 5 bits to represent 4 bits.
2 Sends 6 bits to represent 4 bits.
3 Sends 7 bits to represent 4 bits.
4 Sends 8 bits to represent 4 bits.

**Command with Response Examples**

AT+FEC=1

OK

AT+FEC?

1

OK

help AT+FEC

AT+FEC: Configure Forward Error Correction bytes (1 to 4)

OK

AT+FEC=?

AT+FEC: (1-4)

OK

**AT+CRC  Cyclical Redundancy Check**

Enable or disable Cyclical Redundancy Check (CRC) for uplink and downlink packets. Must be enabled to be compliant with LoRaWAN. Packets received with a bad CRC are discarded.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CRC=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+CRC</td>
</tr>
<tr>
<td>AT+CRC?</td>
</tr>
<tr>
<td>AT+CRC=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

0 CRC disabled
1 CRC enabled (Default)

**Command with Response Examples**

AT+CRC=1
OK

AT+CRC?
1

OK

help AT+CRC
AT+CRC: Enable/disable CRC (0: off, 1: on)

OK

AT+CRC=?
AT+CRC: (0,1)

OK

**AT+ADR Adaptive Data Rate**

Enable or disable adaptive data rate for your device. For more information on Adaptive Data Rate, refer to your device's Developer Guide.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ADR=&lt;parameter1&gt;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Command with Response Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ADR=0</td>
</tr>
</tbody>
</table>

OK

AT+ADR?
0

OK

AT+ADR=0
OK

AT+ADR?
0

OK

help AT+ADR
AT+ADR: Enable/disable Adaptive Data Rate (0: off, 1: on)
OK

AT+ADR=?
AT+ADR: (0,1)

OK
**AT+TXDR  TX Data Rate**

Sets the current data rate to use, DR0-DR15 can be entered as input in addition to (7-12) or (SF_7-SF_12). Output has changed as shown in the following table:

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+TXDR</td>
<td>AT+TXDR</td>
</tr>
<tr>
<td>SF_12</td>
<td>DR0 - SF12BW125</td>
</tr>
<tr>
<td>OK</td>
<td>OK</td>
</tr>
</tbody>
</table>

**Note:** Data rate is directly related to spreading factor. Spreading factor determines the amount of redundant data spread across the transmission. A higher spreading factor means more redundant data is transmitted, which results in a longer range but a lower data rate. For more information on spreading factor, refer to the device's developer guide.

**US 915 Data Rates Max Payload (bytes)**

- DR0 : 11
- DR1 : 53
- DR2 : 125
- DR3 : 242
- DR4 : 242

**EU 868 Data Rates Max Payload (bytes)**

- DR0 : 51
- DR1 : 51
- DR2 : 51
- DR3 : 115
- DR4 : 242
- DR5 : 242
- DR6 : 242
- DR7 : 242

**AU 915 Data Rates Max Payload (bytes)**

- DR0 : 51
- DR1 : 51
- DR2 : 51
- DR3 : 115
- DR4 : 242
- DR5 : 242
- DR6 : 242

**KR 920 Data Rates Max Payload (bytes)**

- DR0 : 51
- DR1 : 51
- DR2 : 51
- DR3 : 115
- DR4 : 242
- DR5 : 242
SENDING AND RECEIVING PACKETS

IN 865 Data Rates Max Payload (bytes)

<table>
<thead>
<tr>
<th>DR</th>
<th>Payload (bytes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>51</td>
</tr>
<tr>
<td>1</td>
<td>51</td>
</tr>
<tr>
<td>2</td>
<td>51</td>
</tr>
<tr>
<td>3</td>
<td>115</td>
</tr>
<tr>
<td>4</td>
<td>242</td>
</tr>
<tr>
<td>5</td>
<td>242</td>
</tr>
<tr>
<td>7</td>
<td>242</td>
</tr>
</tbody>
</table>

**Note:** There is no DR6 for India.

AS 923 Data Rates Max Payload (bytes)

<table>
<thead>
<tr>
<th>DR</th>
<th>Payload (bytes)</th>
<th>Dwell</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>51</td>
<td>N/A</td>
</tr>
<tr>
<td>1</td>
<td>51</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>51</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>115</td>
<td>53</td>
</tr>
<tr>
<td>4</td>
<td>242</td>
<td>125</td>
</tr>
<tr>
<td>5</td>
<td>242</td>
<td>242</td>
</tr>
<tr>
<td>6</td>
<td>242</td>
<td>242</td>
</tr>
<tr>
<td>7</td>
<td>242</td>
<td>242</td>
</tr>
</tbody>
</table>

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+TXDR=&lt;parameter1&gt;</td>
<td>Set the Tx data rate for all channels</td>
</tr>
<tr>
<td>help AT+TXDR</td>
<td></td>
</tr>
<tr>
<td>AT+TXDR?</td>
<td></td>
</tr>
<tr>
<td>AT+TXDR=?</td>
<td></td>
</tr>
</tbody>
</table>

**Command with Response Examples**

AT+TXDR=3

OK

AT+TXDR?

DR0 - SF12BW125

OK

help AT+TXDR

AT+TXDR: Set the Tx data rate for all channels

OK

AT+TXDR=?

AT+TXDR: DR0-DR15, Depends on channel plan.
OK

**AT+SDR  Session Data Rate**
Display the current data rate the LoRaMAC layer is using. It can be changed by the network server if ADR is enabled.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+SDR</td>
</tr>
<tr>
<td>help AT+SDR</td>
</tr>
<tr>
<td>AT+SDR?</td>
</tr>
<tr>
<td>AT+SDR=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**
None

**Command with Response Examples**

AT+SDR
DR0
OK

AT+SDR?
OK

help AT+SDR
OK

AT+SNR=?
OK

**AT+REP  Repeat Packet**
Repeats each frame as many times as indicated or until downlink from network server is received. This setting increases redundancy to increase change of packet to be received by the gateway at the expense of increasing network congestion. When enabled, debug output shows multiple packets being sent. On the Conduit, an MQTT client can listen to the 'packet_recv' topic to see that duplicate packets are received, but not forwarded to the up topic.
**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+REP=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+REP</td>
</tr>
<tr>
<td>AT+REP?</td>
</tr>
<tr>
<td>AT+REP=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

0-15 Number of send attempts. (Default)

**Command with Response Examples**

AT+REP

0

OK

AT+REP?

0

OK

HELP AT+REP

AT+REP: Configure number of times to repeat a packet

OK

AT+REP=?

AT+REP: (0-15)

OK

**Sending Packets**

**AT+SEND Send**

Sends supplied data and opens a receive window to receive data from the gateway/network server. If a data packet is received, it is output following AT+SEND. To configure the receive data format, use the AT+RXO command. Although parameter1 can be up to 242 bytes, it is limited by the payload size as determined by +TXDR setting as shown in the following table:

<table>
<thead>
<tr>
<th>US 915 MHz Device</th>
<th>EU 868MHz Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>DR0-DR4</td>
<td>Payload Size</td>
</tr>
<tr>
<td>DR0</td>
<td>DR0-DR7</td>
</tr>
<tr>
<td></td>
<td>11</td>
</tr>
</tbody>
</table>
+SEND commands response is significantly impacted by the AT+ACK setting. The following table shows the theoretical worst case timing from +SEND to OK or ERROR response using a 915Mhz device. Retransmit delay is random 1-3s delay before a retransmit if an ACK has not been received. Time on air is the amount of time consumed transmitting. Wait for receive is the max time waiting to receive a data packet from the gateway/network server.

Note: These are theoretical values. With no response from the network server, the +ACK=0 time has been observed at about 2.5 seconds.

<table>
<thead>
<tr>
<th>+ACK</th>
<th>Cumulative Retransmit Delay</th>
<th>Cumulative Time on Air (seconds)</th>
<th>Cumulative Wait for Receive (seconds)</th>
<th>Max Response Time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>.4</td>
<td>1-2</td>
<td>2.4</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>.4</td>
<td>3-4</td>
<td>4.4</td>
</tr>
<tr>
<td>2</td>
<td>1-3</td>
<td>.8</td>
<td>5-6</td>
<td>9.8</td>
</tr>
<tr>
<td>3</td>
<td>2-6</td>
<td>1.2</td>
<td>7-8</td>
<td>15.2</td>
</tr>
<tr>
<td>4</td>
<td>3-9</td>
<td>1.6</td>
<td>9-10</td>
<td>20.6</td>
</tr>
<tr>
<td>5</td>
<td>4-12</td>
<td>2</td>
<td>11-12</td>
<td>26</td>
</tr>
<tr>
<td>6</td>
<td>5-15</td>
<td>2.4</td>
<td>13-14</td>
<td>31.1</td>
</tr>
<tr>
<td>7</td>
<td>6-18</td>
<td>2.8</td>
<td>15-16</td>
<td>36.8</td>
</tr>
<tr>
<td>8</td>
<td>7-21</td>
<td>3.2</td>
<td>17-18</td>
<td>42.2</td>
</tr>
</tbody>
</table>

Syntax

Command

AT+SEND=<parameter1>
help AT+SEND
AT+SEND=?”

Parameters and Values

Parameter1

Up to 242 bytes of data or the maximum payload size based on spreading factor (See AT+TXDR)
Command with Response Examples

AT+SEND=<data to send>
<data received from the gateway/network server>
OK

AT+SEND <data to send> (the “=” sign is optional)
<data received from the gateway/network server>
OK

AT+SEND=This is a test with SF10
Data exceeds datarate max payload
ERROR

AT+SEND (sends an empty packet and opens a receive window)
<data received from the gateway/network server>
OK

AT+SEND
Network Not Joined
ERROR

help AT+SEND
AT+SEND: Sends supplied packet data one time and return response, (max:242 bytes)
OK

AT+SEND=?
AT+SEND: (string:242)
OK

AT+SENDB Send Binary
Functions as the +SEND command, but sends hexadecimal data.

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+SENDB=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+SENDB</td>
</tr>
<tr>
<td>AT+SENDB=?</td>
</tr>
</tbody>
</table>
Parameters and Values

Parameter1

String of up to 242 eight bit hexadecimal values. Each value may range from 00 to FF.

Command with Response Examples

AT+SENDB=6174 (sends the letter a and t)
<data received from the gateway/network server>
OK

help AT+SENDB
AT+SENDB: Sends supplied binary (hex) packet data one time and return response
OK

AT+SENDB=?
AT+SENDB: (hex:242)
OK

Receiving Packets

AT+RECV Receive Once

Displays the last payload received. It does not initiate reception of new data. Use +SEND to initiate receiving data from the network server. Rx Packet pin is brought high when packet is received. When you issue a new command, the pin is reset (mDot:D12, xDot:GPIO1). AT+RECV retrieves the packet and resets the pin.

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+RECV</td>
</tr>
<tr>
<td>help AT+RECV</td>
</tr>
<tr>
<td>AT+RECV=?</td>
</tr>
</tbody>
</table>

Parameters and Values

None

Command with Response Examples

AT+RECV
<last received data payload>
OK

help AT+RECV
AT+RECV: Receive and display one packet.

OK

AT+RECV=?
AT+RECV: (string:242) or (hex:242)

OK

**Pin Output**

Rx Packet pin is brought high when packet is received. When you issue a new command, the pin is reset (mDot:D12, xDot:GPIO1). AT+RECV retrieves the packet and resets the pin.

**AT+RXO Receive Output**

Formats the receive data output. Data is processed into hexadecimal data, left unprocessed/raw, in serial data mode, or extended hexadecimal format.

- Hexadecimal outputs the byte values in the response.
- Raw/Unprocessed outputs the actual bytes on the serial interface.
- Serial outputs:

  - **Downlink:**
    - Ack Requested: 1 byte: 0 = true, 1 = false
    - Rx Address: 4 bytes
    - LSB Frame Count: 4 bytes: LSB
    - Rx Port: 1 Byte
    - Payload: N Bytes

  - **Uplink:**
    - Port: 1 Byte
    - ACK or Repeat: 1 Byte: 0 = ACK, 1 = Repeat
    - # of Acks/Reps: 1 Byte: 0 - 8
    - Payload: N Bytes

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+RXO=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+RXO</td>
</tr>
<tr>
<td>AT+RXO?</td>
</tr>
<tr>
<td>AT+RXO=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

- Parameter1
  - 0 Hexadecimal (Default)
  - 1 Raw/Unprocessed
2 Used to send payloads in serial data mode.
3 Extended Hexadecimal format

**Command with Response Examples**

```
AT+RXO=0
OK

AT+RXO?
0
OK

help AT+RXO
AT+RXO: Set the Rx output type (0:hexadecimal, 1:raw, 2:serial, 3:extended_hex)
OK

AT+RXO=?
AT+RXO: (0,1,2,3)
OK
```

**AT+DP Data Pending**

Indicates there is at least one packet pending on the gateway for this end device. This indication is communicated to the end device in any packet coming from the server. Each packet contains a data pending bit.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+DP</td>
</tr>
<tr>
<td>help AT+DP</td>
</tr>
<tr>
<td>AT+DP?</td>
</tr>
<tr>
<td>AT+DP=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None

**Command with Response Examples**

```
AT+DP
0
OK

AT+DP?
```
help AT+DP
AT+DP: Indicator of data in queue on server

OK

AT+DP=?
AT+DP: (0,1)

OK

**AT+TXW**  **Transmit Wait**

Enables or disables waiting for RX windows to expire after sending.

*Note:* Non-blocking operation may disrupt the Dot's ability to receive downlink packets.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+TXW=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+TXW</td>
</tr>
<tr>
<td>AT+TXW?</td>
</tr>
<tr>
<td>AT+TXW=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

0  Do not wait. Not recommended.
1  Wait (Default)

**Command with Response Examples**

AT+TXW=1

OK

AT+TXW?
1

OK

help AT+TXW
AT+TXW: Enable/disable waiting for rx windows to expire after send. (0: off, 1: on)
OK

AT+TXW=?
AT+TXW: (0,1)

OK

**AT+MCRX**  Multicast Rx parameters

Query or set the multicast receive (Rx) parameters which include index, datarate, frequency, and period. For period, if you set the value to -1 then Class C is configured. For all other values (1-8), Class B is set. **Note:** Multicast session is part of the session. Use save, AT+SS, and restore, AT+RS.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+MCRX=&lt;parameter1&gt;,&lt;parameter2&gt;,&lt;parameter 3&gt;, &lt;parameter4.&gt;</td>
<td></td>
</tr>
<tr>
<td>help AT+MCRX</td>
<td></td>
</tr>
<tr>
<td>AT+MCRX=&lt;parameter 1&gt;</td>
<td></td>
</tr>
<tr>
<td>AT+MCRX=?</td>
<td></td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

1- 8 (index)

Parameter2

DR0 - DR15 (datarate)

Parameter3

UINT (frequency)

Parameter4

-1 - 7 (1-7: period, -1: Class C)

**Command with Response Examples**

AT+MCRX=1,2,923300000,1
Set Multicast Rx Settings: 1,2,923300000,1

OK

AT+MCRX=1
DR2,923300000,1

OK

help AT+MCRX
AT+MCRX: Multicast Rx Settings

OK

AT+MCRX=?
AT+MCRX: (1-8), (DR0-DR15), (FREQ), (-1-7:PERIOD, -1:CLASS_C)

OK

Statistics

AT&R   Reset Statistics

Resets device statistics.

Note: Reset includes all statistics displayed with the AT&S command.

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT&amp;R</td>
</tr>
<tr>
<td>help AT&amp;R</td>
</tr>
<tr>
<td>AT&amp;R=?</td>
</tr>
</tbody>
</table>

Parameters and Values

None

Command with Response Examples

AT&R

OK

help AT&R
AT&R: Reset statistics

OK

AT&R=?
AT&R: NONE

OK

AT&S   Statistics

Displays device statistics including join attempts, join failures, packets sent, packets received and missed acks. Use AT&R to reset/clear the statistics.
Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT&amp;S</td>
</tr>
<tr>
<td>help AT&amp;S</td>
</tr>
<tr>
<td>AT&amp;S=?</td>
</tr>
</tbody>
</table>

Parameters and Values

None

Command with Response Examples

AT&S

Join Attempts: 1
Join Fails: 0
Up Packets: 25
Down Packets: 5
Missed Acks: 0

OK

help AT&S
AT&S: Display statistics

OK

AT&S=?
AT&S: TABLE

OK

AT+RSSI Signal Strength

Displays signal strength information for all packets received from the gateway since the last reset. There are four signal strength values, which, in order, are: last packet RSSI, minimum RSSI, maximum RSSI and average RSSI. Values range from -140dB to 0dB.

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+RSSI</td>
</tr>
<tr>
<td>help AT+RSSI</td>
</tr>
<tr>
<td>AT+RSSI?</td>
</tr>
</tbody>
</table>
**Command**

<table>
<thead>
<tr>
<th>Command</th>
<th>AT+RSSI=?</th>
</tr>
</thead>
</table>

**Parameters and Values**

None

**Command with Response Examples**

```plaintext
AT+RSSI
-54, -54, -50, -52
OK

AT+RSSI?
0, 0, 0, 0
OK

help AT+RSSI
AT+RSSI: Displays signal strength information for received packets: last, min, max, avg
OK

AT+RSSI=?
AT+RSSI: (-140-0),(-140-0),(-140-0),(-140-0)
OK
```

**AT+LBTRSSI**  
**Listen Before Talk Signal Strength**

Read the LBTRSSI.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
<th>AT+LBTRSSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>help AT+LBTRSSI</td>
<td>AT+LBTRSSI</td>
</tr>
<tr>
<td>AT+LBTRSSI?</td>
<td>AT+LBTRSSI=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None

**Command with Response Examples**

```plaintext
AT+LBTRSSI
-54, -54, -50, -52
```
OK

AT+LBTRSSI?
0, 0, 0, 0

OK

help AT+LBTRSSI
AT+LBTRSSI:
OK

AT+LBTRSSI=?
AT+LBTRSSI: (-140-0), (-140-0), (-140-0), (-140-0)

OK

**AT+SNR  Signal to Noise Ratio**

Displays signal to noise ratio for all packets received from the gateway since the last reset. There are four signal to noise ratio values, which, in order, are: last packet SNR, minimum SNR, maximum SNR and average SNR. Values range from -20dBm to 20dBm.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+SNR</td>
</tr>
<tr>
<td>help AT+SNR</td>
</tr>
<tr>
<td>AT+SNR?</td>
</tr>
<tr>
<td>AT+SNR=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None

**Command with Response Examples**

AT+SNR
2.9, 2.8, 3.0, 2.9

OK

AT+SNR?
2.9, 2.8, 3.0, 2.9

OK

help AT+SNR
AT+SNR: Display signal to noise ratio of received packets: last, min, max, avg
Serial Data Mode

**AT+SD**  Serial Data Mode

Reads serial data, sends packets, and then sleeps using wake settings. The escape sequence is `+++`.

- There are one second guard times for `+++`. After sending data and before entering `+++`, you must wait one second. After entering `+++` and before sending other data, you must also wait one second.
- When `+++` is received to escape serial data mode all buffer data will be discarded.
- CTS is handled by the serial driver and is relative to its buffer size. When flow control is enabled, see AT&K.
- mDot firmware serial buffer size is 512 bytes.
- If an RX packet requires an ACK or data pending bit is set, an empty packet is sent automatically.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+SD</td>
</tr>
<tr>
<td>help AT+SD</td>
</tr>
<tr>
<td>AT+SD=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None

**Command with Response Examples**

```
AT+SD
CONNECT
<send data>
<send +++ to escape>
OK

help AT+SD
AT+SD: Enter serial data mode, exit with '+++'

OK
```
**AT+SMODE**   **Startup Mode**

Configures which operation mode the end device powers up in, either AT command mode or serial data mode.

- **AT Command mode**: The end device powers up or resets in command mode. AT commands are used to send and receive data.
- **Serial data mode**: Allows the end device to send and receive data without entering AT commands. Data is sent and received based on wake command settings. This mode requires network join mode to be set for either auto join or peer-to-peer mode. (AT+NJM=2 or 3).

**Note**: To exit serial data mode, reset the end device and input `+++` within one second. If the end device responds to AT commands, the `+++` was successful. After exiting data mode issue AT+SMODE=0 to disable data mode and AT&W to save the change.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+SMODE=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+SMODE</td>
</tr>
<tr>
<td>AT+SMODE?</td>
</tr>
<tr>
<td>AT+SMODE=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1  
0    AT command mode (Default)  
1    Serial data mode

**Command with Response Examples**

AT+SMODE=0  
OK

AT+SMODE?  
0

OK

help AT+SMODE
AT+SMODE: 0: AT command mode, 1: Serial data mode

OK

AT+SMODE=?
AT+SMODE: (0,1)

OK

**AT+SDCE**   **Serial Data Clear on Error**

Sets the device to either keep or discard data in the serial buffer when an error occurs.
In serial data mode, the dot wakes periodically to received data on the serial pins and transmit out the radio. If the data cannot be sent, this setting indicates the how device handles the buffered data. Data can either be kept in the buffer to be resent until successful or be discarded.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+SDCE=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+SDCE</td>
</tr>
<tr>
<td>AT+SDCE?</td>
</tr>
<tr>
<td>AT+SDCE=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1
- 0       Data that cannot be sent remains in the serial buffer for later transmission
- 1       Data that cannot be sent is discarded

**Command with Response Examples**

```
AT+SDCE
1
OK

AT+SDCE?
1
OK

help AT+SDCE
AT+SDCE: Serial clear on error if enabled data that cannot be sent will be discarded
OK

AT+SDCE=?
AT+SDCE: (0:off,1:on)
OK
```
Chapter 5 – Power Management

**AT+SLEEP  Sleep Mode**

Puts the end device in sleep mode. The end device wakes on interrupt or interval based on AT+WM setting. Once awakened, use AT+SLEEP again to return to sleep mode.

**Note:** Deep sleep is not available for mDot devices.

**Deep Sleep** (ST Micro standby mode) is the lowest power mode. All RAM is lost and peripherals are off. You can use backup registers to retain the state over sleep. The dot library keeps the running state in the backup registers to be reloaded automatically to maintain the session. Execution begins at the start of the program as it would from power up.

**Sleep** (ST Micro stop mode) maintains RAM and keeps peripherals on. Execution resumes from the call to sleep.

If you need to wake the device at a specific 1 msec timing, take the following values into account.

- Waking from Deep Sleep takes 314-407 usec
- Waking from Sleep takes 13-14 usec
- RTC period is 30.5 usec

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+SLEEP=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+SLEEP</td>
</tr>
<tr>
<td>AT+SLEEP=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

- 0  Deep sleep (ST Micro standby mode)
- 1  Sleep (ST Micro stop mode)

**Command with Response Examples**

```
AT+SLEEP

AT+SLEEP=0

AT+SLEEP=1

help AT+SLEEP
AT+SLEEP: Enter sleep mode

OK

AT+SLEEP=?
```
AT+SLEEP: NONE

OK

**AT+AS** Auto Sleep

**Deprecated**

*This command has been deprecated in version 3.2. Use the Mbed sleep manager.*

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+AS=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+AS</td>
</tr>
<tr>
<td>AT+AS?</td>
</tr>
<tr>
<td>AT+AS=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Disable auto sleep (Default)</td>
</tr>
<tr>
<td>1</td>
<td>Enable auto sleep</td>
</tr>
</tbody>
</table>

**Command with Response Examples**

AT+AS=0

OK

help AT+AS

AT+AS: Set auto sleep (0: DISABLE, 1: ENABLE)

OK

AT+AS=?

AT+AS: (0–1)
**AT+WM**  **Wake Mode**

Configures the end device to wake from sleep mode either on a time interval (set by AT+WI) or by an interrupt. For details on interval mode, refer to +WI. For details on interrupt mode, refer to +WP.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+WM=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+WM</td>
</tr>
<tr>
<td>AT+WM?</td>
</tr>
<tr>
<td>AT+WM=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

<table>
<thead>
<tr>
<th>Parameter1</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Wake on interval. (Default)</td>
</tr>
<tr>
<td>1</td>
<td>Wake on interrupt</td>
</tr>
</tbody>
</table>

**Command with Response Examples**

```
AT+WM=0
OK

AT+WM?
0
OK
```

```
help AT+WM
AT+WM: Wakeup mode, INTERRUPT uses DIO7 as wake-up pin (0:INTERVAL,1:INTERRUPT)
OK

AT+WM=?
AT+WM: (0:INTERVAL,1:INTERRUPT)
OK
```
AT+WI  Wake Interval

When using wake mode set to interval, use this command to configure the number of seconds the end device sleeps when in sleep mode. Upon waking, it waits +WD amount of time for an initial character then +WTO amount of time for each additional character.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+WI=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+WI</td>
</tr>
<tr>
<td>AT+WI?</td>
</tr>
<tr>
<td>AT+WI=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

**Parameter1**

2-2147483647 seconds (Default is 10)

**Command with Response Examples**

AT+WI=10

OK

AT+WI?

10

OK

help AT+WI

AT+WI: Wakeup interval (seconds)

OK

AT+WI=?

AT+WI: (2-2147483647) s

OK

AT+WD  Wake Delay

Configures the maximum amount of time to wait for data when the device wakes up from sleep mode. If this timer expires, the device goes back to sleep. If the device received at least one character before this timer expires, the device continues to read input until either the payload is reached or the +WTO timer expires at which time it sends the collected data and goes to sleep.
**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+WD=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+WD</td>
</tr>
<tr>
<td>AT+WD?</td>
</tr>
<tr>
<td>AT+WD=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

2-2147483647 milliseconds (Default is 100)

**Command with Response Examples**

AT+WD=100

OK

AT+WD?

100

OK

help AT+WD

AT+WD: Time to wait for data after wakeup signal (milliseconds)

OK

AT+WTO Wake Timeout

Configures the amount of time that the device waits for subsequent characters following the first character received upon waking. Once this timer expires, the collected data is sent and the end device goes back to sleep.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+WTO=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+WTO</td>
</tr>
<tr>
<td>AT+WTO?</td>
</tr>
<tr>
<td>AT+WTO=?</td>
</tr>
</tbody>
</table>
Parameters and Values

Parameter1

0-65000 milliseconds (Default is 20)

Command with Response Examples

AT+WTO=20

OK

AT+WTO?
20

OK

help AT+WTO
AT+WTO: Read serial data until timeout (milliseconds)

OK

AT+WTO=?
AT+WTO: (0~65000) ms

OK

**AT+ANT Antenna Gain**

Allows a non-default antenna to be used while still adhering to transmit power regulations.

Syntax

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ANT=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+ANT</td>
</tr>
<tr>
<td>AT+ANT?</td>
</tr>
<tr>
<td>AT+ANT=?</td>
</tr>
</tbody>
</table>

Parameters and Values

Parameter1

-128 to 127 (Default is 3)

Command with Response Examples

AT+ANT=3

OK
AT+ANT?
3
OK

help AT+ANT
AT+ANT: Gain in dBi of installed antenna (-128-127)
OK

AT+ANT=?
AT+ANT: (-128-127)
OK
Chapter 6 – Testing and Compliance

**AT+RXDR  Receive Data Rate**

Sets the receive data rate. Used to configure the receive data rate that AT+RECVC uses for receiving packets.

*Note:* This command is used for compliance testing. It is not intended for the typical end user.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+RXDR=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+RXDR</td>
</tr>
<tr>
<td>AT+RXDR?</td>
</tr>
<tr>
<td>AT+RXDR=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

<table>
<thead>
<tr>
<th>7-10</th>
<th>915MHz model (Default is 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-12</td>
<td>868MHz model</td>
</tr>
</tbody>
</table>

**Command with Response Examples**

AT+RXDR=9

OK

AT+RXDR?

SF_9

OK

help AT+RXDR

AT+RXDR: Set the Rx data rate

OK

AT+RXDR=?

AT+RXDR: (7-10)

OK

**EU 868MHz**

AT+RXDR?
**AT+RXF  Receive Frequency**

**Deprecated**

Note: Beginning in firmware version 3.2, this command has been removed from production firmware. It will remain available in de-bug firmware.

Configures the frequency that +RECVC listens to for received packets.

Note: This command is used for compliance testing. It is not intended for the typical end user.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+RXF=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+RXF</td>
</tr>
<tr>
<td>AT+RXF?</td>
</tr>
<tr>
<td>AT+RXF=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

0

902000000-928000000 (Default is 903700000)

**Command with Response Examples**

AT+RXF=902123456

OK

AT+RXF?

902123456

OK

help AT+RXF

AT+RXF: Set the Rx frequency for +RECV,+RECVC

OK

AT+RXF=?

AT+RXF: (0,902000000-928000000)

OK
**AT+RECVC  Receive Continuously**

**Deprecated**

*Note: Beginning in firmware version 3.2, this command has been removed from production firmware. It will remain available in de-bug firmware.*

Causes the device to receive packets continuously on the frequency configured via AT+RXF and at the data rate configured via AT+RXDR. Use +++ to exit this mode. It can take many seconds to get an OK following +++.

*Note: This command is used for compliance testing. It is not intended for the typical end user.*

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+RECVC</td>
</tr>
<tr>
<td>help AT+RECVC</td>
</tr>
<tr>
<td>AT+RECVC?</td>
</tr>
<tr>
<td>AT+RECVC=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

None

**Command with Response Examples**

AT+RECVC

OK

help AT+RECVC

AT+RECVC: Continuously receive and display packets. (escape sequence: +++)

OK

AT+RECVC=?

AT+RECVC: out: (string:242) or (hex:242)

OK

**AT+SENDC  Send**

Used for testing. Sends un-modulated data continuously.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+SENDC=&lt;parameter1&gt;,&lt;parameter2&gt;,&lt;parameter3&gt;</td>
</tr>
<tr>
<td>help AT+SENDC</td>
</tr>
</tbody>
</table>
Command

<table>
<thead>
<tr>
<th>Command</th>
<th>AT+SEND=？</th>
</tr>
</thead>
</table>

Parameters and Values

Parameters

- `<paramet er1>`: Timeout
- `<paramet er2>`: Frequency
- `<paramet er3>`: Power

Command with Response Examples

AT+SEND=<data to send>
<data received from the gateway/network server>

OK

help AT+SEND

AT+SEND: Sends packet data continuously (max:242 bytes)

OK

AT+SEND=？

AT+SEND: (string:242)

OK

**AT+SENDI  Send on Interval**

Functions the same as the +SEND command, except that it takes an additional parameter as the interval then continually sends and receives on that interval. Issue +++ to stop sending.

Note: This command is used for compliance testing. It is not intended for the typical end user.

Syntax

<table>
<thead>
<tr>
<th>Command</th>
<th>AT+SENDI=&lt;parameter1&gt;, &lt;parameter2&gt;</th>
</tr>
</thead>
</table>

help AT+SENDI

AT+SENDI=？

Parameters and Values

Parameter1

100-2147483647 milliseconds
Parameter2

Up to 242 bytes of data or the max payload size based on the spreading factor (see AT+TXDR)

**Command with Response Examples**

AT+SENDI=1000,<data to send>
<data received from the gateway/network server>

OK

AT+SENDI
Invalid arguments

ERROR

help AT+SENDI
AT+SENDI: Sends supplied packet data on interval between sends, output any received packets (escape sequence: +++)

OK

AT+SENDI=?
AT+SENDI: (100-2147483647) ms,(string:242)

OK

**AT+TXF**  Transmit Frequency

Set Tx frequency used in Peer-to-Peer mode. To avoid interference with LoRaWAN networks, use 915.5-919.7 MHz for US 915 devices and a fixed 869.85 MHz for EU 868 devices.

**Note:** The parameter ranges below are used for compliance testing and are not intended for the typical end user.

**Syntax**

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+TXF=&lt;parameter1&gt;</td>
</tr>
<tr>
<td>help AT+TXF</td>
</tr>
<tr>
<td>AT+TXF?</td>
</tr>
<tr>
<td>AT+TXF=?</td>
</tr>
</tbody>
</table>

**Parameters and Values**

Parameter1

US915 - (0,902000000-928000000)
EU868 - (0,863000000-870000000)
Command with Response Examples

AT+TXF=902123456
OK

help AT+TXF
AT+TXF: Set Tx frequency
OK

AT+TXF?
902123456
OK

US 915MHz
AT+TXF=?
AT+TXF: (0,902000000-928000000)
OK

EU 868 MHz
AT+TXF=?
AT+TXF: (0,863000000-870000000)
OK
Chapter 7 – Examples

Network Configuration and Joining

Configure Network ID and Network Key with either a hexadecimal value or name/passphrase.

- To configure with a hexadecimal value, provide a first argument of 0:
  \[ \text{AT+NI}=0,001122334556677 \]
  OK
  \[ \text{AT+NK}=0,001122334556677001122334556677 \]
  OK

- To configure with a name/passphrase value provide a first argument of 1:
  \[ \text{AT+NI}=1,\text{MTS\text{-}LORA\text{-}1} \]
  OK
  \[ \text{AT+NK}=1,\text{MTS\text{-}LORA\text{-}PASSPHRASE} \]
  OK

US 915MHz - Frequency Sub-band

Before joining to a Conduit in the US, set the frequency sub-band to join using the frequencies the Conduit is configured to listen on.

To configure the frequency sub-band:

\[ \text{AT+FSB}=5 \]
OK
Join Mode

The Dot supports both OTA and manual provisioning or joining. See OTA Activation in Chapter 3 Network Management.

- To configure for OTA join mode and connect to the network:
  
  AT+NJM=1

  OK
  AT+JOIN

  OK

- To configure for AUTO OTA join mode and connect to the network, if you are not already joined, a join attempt will be made:

  AT+NJM=2

  OK

  Joining Network... Network Joined

  OK

- To configure for MANUAL provisioning, change the mode, then set the network address and session keys:

  AT+NJM=0

  OK

  AT+NA=0011223344556677

  OK

  AT+DSK=00112233445566770011223344556677

  OK

  AT+NSK=00112233445566770011223344556677

  OK
Ensuring Network Connectivity

To ensure the Dot is still connected to the network, request a response from the server. One method is to require ACKs for each packet, but under a heavy load, the server may not be able to respond to every packet. The other option is to periodically require an ACK using AT+LCC, this maintains join status without overburdening the network server. In the following examples, the gateway is powered off to simulate network loss. Refer to *Ensuring Network Connectivity* in Chapter 3 Network Management.

- Using acknowledgments to detect network loss requires a response for each packet. With a threshold set to one, the network is no longer joined after only one lost packet. Increasing the LCT value allows some missed packets without the need to rejoin the network. If AUTO_OTA is enabled the device automatically attempts to rejoin after network is lost.

  [Gateway Powered On]
  
  AT+JOIN
  Successfully joined network

  OK
  AT+ACK=1

  OK
  AT+LCT=1

  OK
  AT+SEND=message

  OK
  [Gateway Powered Off]

  AT+NJS
  1

  OK
  AT+SEND=message
  Operation Timed Out - ACK not received

  OK
  AT+NJS
  0

  OK

- When using link checks to detect network loss, you can configure how many responses are required. With a threshold set to one, the network is no longer joined after only one lost packet. Increasing the LCT value allows some missed packets without the need to rejoin the network. If AUTO_OTA is enabled the device automatically attempts to rejoin after network is lost.

  [Gateway Powered On]

  AT+JOIN
  Successfully joined network
OK
AT+LCC=2

OK
AT+LCT=1

OK
AT+SEND=message

OK
[Gateway Powered Off]
AT+SEND=message

OK
AT+NJS
1

OK
AT+SEND=message
Network Not Joined

ERROR
AT+NJS
0

OK

**Serial Mode**

Configure the device to wake periodically or on interrupt, wait for data on serial port, send data out, and go back to sleep. Refer to *Chapter 5, Power Management* for more information.

- Configure the device to wake up after 10 seconds of sleep and send data from the serial port:

  AT+WM=0

  OK
  AT+WI=10

  OK
  AT+WD=100

  OK
  AT+WTO=20

  OK
  AT+SMODE=1

  OK
  AT&W
Device resets into Serial Mode.

**Peer to Peer**

mDots using 1.0.8 AT Firmware or Library can be configured for Peer to Peer communication. To allow communication between mDots, configure two or more mDots with the same network settings. Enabling ACKs guarantees packet delivery; however, this may disrupt higher level protocols such as zmodem or ymodem file transfers. Communication between mDots is half-duplex, so both ends should not transmit at the same time or communication will be disrupted.

The frequency can be set for US 915 models. We advise using 915.5-919.7 to avoid interference with LoRa Networks.

For Europe 868 models, use a fixed frequency, 869.85, with 7 dBm power setting to allow 100% duty-cycle usage.

**Configuration**

This example sets up each side with identical settings and starts serial data mode. Then, text can be entered into a terminal on either side and it will show as received on the other mDot.

```
AT+NJM=3
AT+NA=00112233
AT+NSK=0011223300112233011223300112233
AT+DSK=33221100332211003322110033221100
AT+TXDR=DR8 (US:DR8-DR13, EU:DR0-DR6)
AT+TXF=915500000 (US-ONLY:915.5-919.7)
AT&W
ATZ
AT+SD
```
Peer-to-Peer Throughput

US915 Datarate - Time On Air

EU988 Datarate - Time On Air

US915 Datarate - Throughput

EU988 Datarate - Throughput